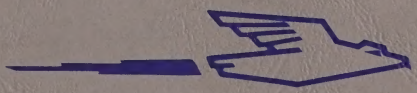
INSTRUCTION MANUAL

PX32C

DIGITAL PULSE GENERATOR



TRI-PHENIX ELECTRONICS

GARDENA CA. 90248

WARRANTY

ALL TRI-PHENIX PRODUCTS ARE WARRANTED AGAINST DEFECTS IN MATERIAL AND WORKMANSHIP FOR A PERIOD OF ONE YEAR. WE WILL REPAIR OR REPLACE PRODUCTS WHICH PROVE TO BE DEFECTIVE DURING THE WARRANTY PERIOD. THIS IS IN LIEU OF ANY OTHER WARRANTY EXPRESSED OR IMPLIED.

TRI-PHENIX ELECTRONICS
15823 S. SAN PEDRO ST.
GARDENA, CA. 90248
(213) 515-7223
(213) 772-4765

MODEL PX32 IEEE
PROGRAMMABLE PULSE GENERATOR

T A B L E O F C O N T E N T S

SECTION I CHARACTERISTICS
1.1 General Information..... 1
1.2 Specifications..... 1

SECTION II OPERATING INSTRUCTIONS
2.1 General Information..... 3
2.2 Front Panel Controls..... 3
2.3 Rear Panel Connectors..... 4
Table 2-1 Programming Information.. 7

SECTION III CIRCUIT DESCRIPTION
3.1 General Information..... 8
3.2 Module A7, Pulse Former..... 8
3.3 Module A6, D/A Range.....11
3.4 Module A4, D/A Vernier.....12
3.5 Module A2, Logic Power Supply.....13
3.6 Module A10, Output.....13
3.7 Module A8, Output Power Supply.....16
3.8 Module A13, Offset/Amplitude.....17
3.9 Module A11, Tr-Tf.....18
3.10 Module A9, Attenuator.....19
3.11 Module A14, Unregulated PS.....19
3.12 Module A5, A12, Memory Latch.....19
3.13 Module A3, IEEE Control.....19
3.14 Module A15, IEEE Interface.....20

SECTION IV MAINTENANCE
4.1 Preventive Maintenance.....21
4.2 Corrective Maintenance.....21

SECTION V TROUBLESHOOTING
5.1 Procedure.....22
Table 5-1, Troubleshooting.....22

SECTION VI CALIBRATION
6.1 General Information.....29
6.2 Calibration.....29

SECTION VIII LIST OF ILLUSTRATIONS

Outline Dwg.....33
Block Diagram.....34
Wiring 35
Unregulated PS.....39
Logic Power Supply.....41
Pulse Former.....43
Output PS.....45
D/A Range.....47
Attenuator.....49
D/A Vernier.....51
Output.....43
IEEE Interface.....55
Offset/Amplitude.....57
Rise/Fall Time.....59
IEEE Control.....61
Memory Latch.....63

SECTION VIII LIST OF MATERIALS

Pulse Generator PX32 IEEE.....65
Main Chassis Assy.....65
Front Panel Assy.....66
Rear Panel Assy.....66
Power Supply Chassis Assy.....67
Unregulated PS Assy.....67
Extender Board Assy.....67
Logic PS Assy.....68
Pulse Former Assy.....69
D/A Vernier Assy.....70
Attenuator Assy.....70
D/A Range Assy.....71
IEEE Interface Assy.....71
Output Assy.....72
Memory Latch Assy.....73
Offset/Amplitude Assy.....74
Output PS Assy.....75
Rise/Fall Time Assy.....76
IEEE Control Assy.....77

SECTION 1

CHARACTERISTICS

1.1 GENERAL INFORMATION.

The Tri-Phenix PX32 Pulse Generator can be programmed either remotely from an IEEE bus compatible system or by front panel controls. The PX32 can be supplied with either or both methods of programming.

1.2 SPECIFICATIONS.

A. Repetition Rate.

1. Internal.

Zero to 9.99 MHz in 6 ranges to three digits. (20 MHz in the pulse pair mode of operation.) Linearity and accuracy tolerance is plus or minus 2% of full scale from 10 Hz to 9.99 MHz.

2. External.

Zero to 20 MHz. Any waveform between 2 and 10 volts positive will trigger the instrument. Minimum width 20 nsec.

B. Delta Delay.

Zero to 9.99 nsec. in 6 ranges to three digits. Linearity and accuracy tolerance is plus or minus 2% of full scale from 20 nsec. to 9.99 msec. Delta Delay is defined as the time from the undelayed pulse or the first pulse of a pulse pair. The T0 sync pulse precedes the undelayed pulse by approximately 60 nsec. The delay jitter is less than 0.05%.

C. Pulse Width.

20 nsec. to 9.99 msec. in 6 ranges to 3 digits. Linearity and accuracy tolerance is plus or minus 2% of full scale from 20 nsec. to 9.99 msec.. Some compression occurs as 20 nsec. pulse width is approached. The width jitter is less than 0.05%.

D. Pulse Amplitude.

Zero to 9.9 volts (0 to 25 volts G option) in 3 ranges to 2 digits. Linearity and accuracy tolerance is plus or minus 2% of full scale. The output is a 50 ohm source. This provides a 20 volt pulse capability into a high impedance load. Pulse Polarity is programmable either positive or negative.

E. D.C.OffSET. (not available on G option)

Zero to 9.9 volts to 2 digits. Linearity and accuracy tolerance is plus or minus 2% of full scale from zero to 9.9 volts. Offset output is a 50 ohm source. This

provides a 20 volt offset capability into a high impedance load. The Offset amplitude is attenuated by the pulse amplitude attenuators. Offset Polarity is programmable either positive or negative and independent of pulse polarity.

F. Pulse Rise and Fall Time.

Less than 5 nsec. to 9.9 msec. in 6 common ranges to 2 digits. Linearity is 2%. Accuracy is plus or minus 2% of full scale from 10 nsec. to 9.9 msec.. Rise time is limited to 7 msec. due to the 10 msec. maximum pulse width. Rise and Fall time are independent except for having common range.

G. Pulse Distortion.

Less than 5% preshoot, overshoot, undershoot, droop, ringing or other pulse anomalies.

H. Duty Cycle.

At a repetition rate of 20 MHz the maximum duty cycle is approximately 50% At repetition rates of 1 MHz or lower the duty cycle is approximately 90%. At the end of each range there is an interaction which results in a decrease in width as the duty cycle is increased.

I. Gated Operation.

Synchronous or Asynchronous bursts of pulses, pulse pairs or other configurations may be programmed. A negative gate signal of 2 to 8 volts in amplitude is required.

J. Pulse Pair Mode.

Pulse Pair spacing is controlled by programming the delay. Pulse Pair Mode extends the internal repetition rate capability to 20 MHz.

K. Sync Output Pulse.

Sync output pulse (T0) is a minimum 2 volt positive pulse greater than 10 nsec. wide. The delay from an external trigger pulse to the T0 output is less than 15 nsec..

L. Program Levels.

IEEE bus compatible.

M. Power Required.

115 volts ac, 50 to 60 Hz, 100 watts.
220 volts ac, 50 to 60 Hz, 100 watts.
Others available upon request.

N. Size.

5.5 inches high, 19 inches wide, 19 inches deep.

P. Connectors.

All connectors are mounted on rear panel unless otherwise specified. Signal connectors are BNC. Program connector is Amphenol 57-20240-8 or equivalent.

SECTION II

OPERATING INSTRUCTIONS

2.1. GENERAL INFORMATION

This section of the manual provides the basic information required for operating the Model PX32 pulse generator. All parameters can be programmed either by front panel controls or from an IEEE-488 bus. Program format is specified in Table 2.1.

2.2 FRONT PANEL CONTROLS

All controls for the operation of the Model PX32 in the local mode are located on the front panel of the instrument. These controls permit the units to be operated as bench generators or to preset and check remote programs. The controls are clearly labeled and in general are self explanatory. A brief description of each control follows and additional information can be obtained by referring to the appropriate schematic.

A. Power Switch

Connects the AC power to the transformer primaries and lights the ON indicator light when in the ON position.

B. Remote-Local Switch

Selects the program mode of the instrument.

C. Repetition Rate Control

Contains 4 digit switches. The first three select the significant figures of repetition rate and the fourth switch (white) selects the repetition rate range multiplier.

D. Delay Control

Contains 4 digit switches. The first three select the significant figures of delay and the fourth switch (white) selects the delay range multiplier.

E. Width Control

Contains 4 digit switches. The first three select the significant figures of width and the fourth switch (white) selects the width range multiplier.

F. Rise/Fall Control

Contains 5 digit switches. The first two select the significant figures of rise time. The third switch (white) selects the Rise/Fall range multiplier. The last two select the significant figures of fall time.

G. Offset/Amplitude Control (G option has no Offset)

Contains 5 digit switches. The first two select the significant figures of base line offset. The third switch (white) selects the output multiplier as follows.

Range 0 = No Output
Range 1 = Multiplier 0.1 (G option = .25)
Range 2 = Multiplier 0.3 (G option = 1)
Range 3 = Multiplier 1.0 (G option = 2.5)

The last two switches select the significant figures of pulse amplitude.

H. Trigger Select.

A two position toggle switch that selects either internal or external trigger and a push button switch that triggers the unit each time the button is pushed.

I. Gate Select

A three position toggle switch that selects either synchronous or asynchronous gating or, in the mid position, selects gate off. In the off position the external gate signal does not affect the output. In the synchronous position the pulse output will be present only during the interval of the gate signal. The output pulse will be synchronized to the leading edge of the gate signal. In the asynchronous position the pulse output will be present only during the interval of the gate signal but the output will not be synchronized to the gate signal.

J. Mode Select

A two position toggle switch that selects either Pulse-Pair or normal operation. In the normal position the pulse output is delayed from the T0 sync output pulse by an interval that is controlled by the delay controls. In the Pulse-Pair position two output pulses occur and the spacing between the two pulses is controlled by the delay controls.

K. Polarity Select (G option no Offset switch)

Consists of two 2 position toggle switches that select either positive or negative polarity of baseline offset and either positive or negative polarity of pulse output. The switches are independent.

2.3 REAR PANEL CONNECTORS

A. Program Connectors

IEEE-488 Bus connector.

B. Output Connector

A BNC type. The Output has a 50 ohm source impedance. Specified output amplitudes are obtained only if the instrument is terminated by a 50 ohm resistive load.

C. TO Sync Connector

A BNC type. The sync pulse is greater than two volts positive pulse at a frequency determined by the repetition rate.

D. Gate Input Connector

A BNC type. A negative gate 2 to 8 volts is required to gate the unit.

E. Trigger Input

A BNC type. A positive trigger from 2 to 10 volts will trigger the unit.

2.4 REMOTE PROGRAMMING.

The PX32 is IEEE Bus compatible. In general the following IEEE states are applicable to the PX32.

Acceptor Handshake State.
Listener State. The PX32 is a listener only.
Remote Local State.
Device Clear State.
Device Trigger State.

A. Output State

Two methods of controlling the status of the output pulse are provided. One method is inherent to the IEEE system and the other is internal to the PX32.

The PX32 will go to a pulse off state whenever:

1. Bus command Device Clear is received.
2. If PX32 is in the Listener Addressed State
   and a. Selected Device Clear is received.
   or b. Any ASCII code @,A,B,C,D,E,F,G,H,I J,K,L,M,N,O is received.

To turn the PX32 on:

1. Following a Device Clear Command, a Group Execute Trigger (GET) is required.

2. Following a Selected Device Clear Command while in the listener addressed state, a Group Execute Trigger command is required.

3. Following receipt of data representing ASCII codes @ through O while in the Listener Addressed State, an ASCII "X" is required. Note that in certain conditions both "X" and "GET" are required.

The PX32 does not respond to lower case letters.

B. Program Format

The basic PX32 program storage consists of a field of 10 rows and 8 columns. Any point within this field can be selected. Each point in the field has a memory to convert the serial program data to parallel information. All remote program data is received on the program bus. The following ASCII codes are used to program the PX32.

ASCII CODE	Operation	Pulse Generator Function
A	Addresses	Repetition Rate
B	Addresses	Delay
C	Addresses	Width
D	Addresses	Mode Select
E	Addresses	Pulse Amplitude & Polarities
F	Addresses	Offset
G	Addresses	Rise/Fall Time
0	Sets	Zero
1	Sets	One
2	Sets	Two
3	Sets	Three
4	Sets	Four
5	Sets	Five
6	Sets	Six
7	Sets	Seven
8	Sets	Eight
9	Sets	Nine
X	Sets	Output On

Note that each function has an unique address so that the pulse output can be modified in its parameters without the necessity of reprogramming all function if desired.

The basic programming consists of an address followed by the numerical value desired in each significant figure. The PX32 automatically steps through eight significant figures for each address. See Table 2.1. As an example the program:

A1004B2502C1252D1E5032F25G25171 would program.

A	Repetition Rate	100 KHz
B	Delay	2.5 Microseconds
C	Width	1250 Nanoseconds
D	Mode	Pulse-Pair, Internal, Not gated
E	Pulse Amplitude	5.0 volts
		Pulse Positive
		Offset Negative
F	Offset Amplitude	2.5 volts
G	Rise/Fall Time	Rise Time 250 Nanoseconds
		Fall Time 170 Nanoseconds
X	Output State	Turns Pulse On

Note: A "GET" command may also be required to turn the output on if Device Clear or Selected Device Clear have been programmed.

PX32 PROGRAMMING

ASCII	FUNCTION	ASCII 1st #	ASCII 2nd #	ASCII 3rd #	ASCII 4th #	ASCII 5th #
A	REP-RATE	SIGNIFICANT FIGURE	2nd	3rd	MULT	NA
B	DELAY	"	"	"	"	"
C	WIDTH	"	"	"	"	"
D	MODE	0=Norm-Int-not gated 1=PulsePair-Int-not gated 2=Norm-Ext-not gated 3=PulsePair-Ext-not gated 4=Norm-Int-Async gate 5=PulsePair-Int-Async gate 6=Norm-Ext-Async gate 7=Pulsepair-Ext-Async gate 8=Norm-Int-Sync gate 9=PulsePair-Int-Sync gate	NA	NA	NA	"
E	Pulse A	SIGNIFICANT FIGURE	2nd	0=NO 1=.1 2=.3 3= 1	0=+P 0=-0 1=-P 1=+0 2=+P 2=-0 3=-P 3=-0	NA
F	Offset A	SIGNIFICANT FIGURE	2nd	NA	NA	NA
G	RiseFall	SIGNIFICANT FIGURE	2nd	1st	2nd	MULT

TABLE 2.1

SECTION III

CIRCUIT DESCRIPTION

3.1 GENERAL INFORMATION

Refer to the Block Diagrams and the Module Schematics. The PX32 series of Pulse Generators contain plug in circuit cards. (See layout diagram for location.) The basic operation is illustrated in the simplified block diagram. Module A7 generates the pulse information. This module contains the repetition rate oscillator, the delay generating circuits and the width determining circuits. These circuits are controlled by two modules A4 and A6. Module A4 receives the BCD information associated with the significant figures of REP-RATE, delay and width. The program information is converted to analog for control of the REP-RATE, delay and width functions. Module A6 receives the BCD information associated with the range of the functions and converts this information to decimal equivalents for selection of the timing capacitors in the respective circuits. Module A7 provides a start-stop to the pulse shaping module A10. Module A10 contains the Rise/Fall timing circuits which in turn are controlled by Module A11. Module A11 receives the BCD information associated with the significant figures and range of the rise and fall time. The significant figure information is converted to analog for control of rise and fall time. The range information is converted to decimal equivalent for selection of range capacitors. Module A13 receives BCD information related to the significant figures of baseline offset and pulse amplitude. The baseline offset information controls the voltage difference between two power supplies located on Module A8. The Pulse Amplitude information is decoded and controls the current through the pulse output transistor located on Module A10. Other program information regarding Pulse-Pair, Internal/External Trigger, Pulse Polarity, Offset Polarity, and Output Multiplier will be discussed in the circuit description of the modules.

Module A3 decodes the ASCII information from the bus and stores the information into Memory Modules A5 and A12. In the discussions that follow refer to the referenced schematics.

3.2 MODULE A7 - PULSE FORMER. 900A3001C1 (30-01)

The pulse that synchronizes the operation of all circuits is supplied either from an external source, from a manual single pulse front panel control or from the internal variable frequency oscillator. The positive external trigger is coupled into the instrument at J4 and then to terminal F of J15-B. Whenever K1 is energized the signal is coupled through CR-4 and if of proper amplitude causes the tunnel

diode triggering circuit to fire. K1 is controlled by program information received on either terminal H or T of J15-B..

This control circuit of K1 illustrates the operation of the Remote-Local programming system. When the local/remote selector switch is in the remote position terminal R of J15-B is returned to +6 volts. Q15 will conduct if terminal T of J15-B is returned to ground or TTL logic low. When external trigger is remotely programmed this condition exists and Q15 conducts, Q14 is non-conducting, Q13 conducts and activates relay K1. If terminal H of J15-B is at ground Q14 would be non-conducting and K1 activated. Terminal H is returned to the front panel internal/external switch. The arm of this switch and all other front panel switch commons are returned to +6 volts in remote position and to ground in the local position. In remote CR9 is connected to +6 volts and cannot interfere with remote operation. In local operation terminal R of J15-B is grounded and Q15 cannot conduct thus isolating remote information. CR5 and CR6 provide bias for Q14. This method of program operation is used throughout the instrument and will not be discussed in any subsequent section of the manual.

Each time the single pulse front panel push-button is depressed a positive voltage is coupled through CR3 to the tunnel diode triggering circuit. The filter network R11, C2, R13 and R12 prevents switch bounce from resulting in multiple trigger.

The internal variable frequency oscillator consists of transistors Q2, Q3, Q4 and associated circuitry. Assume conditions of terminal 21 of J15-A returned to a negative source through a precision resistor and the parallel combination of C9 and C10 charged to a level such that Q3 is non-conducting. The condensers will then discharge through Q4 at a rate dependent on the magnitude of the negative supply and the value of the precision resistor. When the timing condensers discharge to the point where Q3 conducts, the condenser is recharged through Q3 and the cycle is repeated. Q2 provides regeneration. Q6 couples the developed signal to the tunnel diode triggering circuit. Q5 couples the developed signal to the sync pulse differential output amplifier. This sync circuit provides a wider sync pulse at lower rep-rates.

The selection of timing condensers C5 through C10 is determined by the REP-RATE range programmed. Relays K1 through K6 are activated by control lines J15-A (4,3,D,E,S). These relays insert the desired capacity into the timing circuit. The selection is determined in the range decoder module A6. Note that range 4 is selected when none of the control lines are active. The voltage to which terminal 21 of J15-A is returned and the value of the series resistor is determined by D/A Range module A6.

An inhibit is placed on the REP-RATE oscillator when either external trigger or synchronous gate is programmed. This inhibit signal is coupled into the module at terminal C of J15-B. During inhibit this line is positive which clamps the emitter of Q2 and holds the oscillator off. The inhibit is removed during gate period and the oscillator starts in sync with the leading edge of the gate.

When a trigger from either of the three sources arrives at the tunnel diode CR2, Q7 will conduct. The resulting pulse is differentiated by C1, shaped by L4 and a sharp positive trigger is developed at the collector of Q10. This trigger is coupled to the sync pulse differential output amplifier and mixed with the previously discussed signal. The TO sync pulse is present at terminal S of J15-B.

The developed trigger is also coupled through CR8 to the delay circuitry and CR7 to the width circuitry. These signals are gated by Q11 and Q12. Unless Pulse-Pair mode or synchronous gate is programmed terminal 2 of J15-B is positive. Q11 conducts inhibiting the trigger through CR7. If synchronous gate is programmed terminal 1 of J15-B is also positive. Q12 conducts inhibiting the trigger through CR8. Thus in synchronous gate mode these diodes are active only during the gate period. Pulse-Pair mode activates CR7 but is dependent on the state of the synchronous gate signal. The status of these control lines is determined by D/A Range module A6.

A trigger through CR8 causes Q18 to conduct and Q19 to cut off. Q18 is held on by feedback through Q17. Q21 which was conducting is turned off. Assume conditions with terminal 8 of J15-A returned to a negative voltage through a series resistor. The parallel condensers C14 and C15 are discharged since Q21 was conducting. When Q21 turns off the condensers will charge through R51, Q24, R50 and the series resistor to the negative supply. The condensers will charge until the emitter of Q23 reaches a turn on voltage level. This level is determined by the voltage on terminal 6 of J15-A which is developed in module A4. This is the delay vernier. When Q23 conducts a trigger is developed by tunnel diode CR11 which causes Q22 to conduct. Consequently Q19 conducts and regenerative action returns the circuit to the initial conditions awaiting another trigger. The output from the delay circuit is developed across R45, differentiated and coupled to the width circuitry. The selection of condensers C14 through C19 is determined by the delay range programmed. Relays K7 through K11 insert the proper condenser into the timing circuit. To compensate for condenser tolerances a separate calibration control for each range is inserted as the series resistor from terminal 8 Of J15-A to the negative voltage source. (See module A6) The operation of the width circuitry Q28 through Q36 is identical to the delay except that the triggers are received either from the delay output

or through CR7 in Pulse-Pair mode. The output from the width circuitry is coupled through the differential amplifier Q35, Q36 to terminals 12 and N of J15-B. Relays K12 through K16 provide for width range selection. Vernier is supplied at terminal 14 of J15-B. Calibration signal at terminal 6 of J15-B.

3.3 MODULE A6 D/A RANGE. 900A3002C1 (30-02-1 and 30-02-2)

BCD information associated with the selection of repetition rate range is received on the input terminals associated with transistors Q1 through Q3. Q4 through Q7 and associated circuitry converts the BCD information to a decimal equivalent. As an example assume remote operation and range 3 Programmed. Analysis will show that the only conducting path is through Q12, Q8 and Q5 which corresponds to range three of repetition rate. Analysis will show that other BCD inputs are converted to the selected range. The decoded range information present at terminals 4, 5, 6, 20 and 22 of J14-A energize relays K2 through K6 on pulse former module A7. In addition selection of a particular range selects the desired calibration control. Assume range 3 then Q18 conducts. (If range three is not selected terminal 20 of J14-A is positive relay voltage and Q18 is non-conducting.) When Q18 conducts a current flows through the potentiometer R23 to terminal A of J14-A. This current is applied to the logic power supply as feedback for the repetition rate negative supply and thus the condenser discharge path of the repetition rate oscillator can be adjusted for each range by the associated control. (R20 through R25.).

The delay and width range selection and calibration is identical to repetition rate except for the calibration control. Again assuming a delay range of BCD 3 the delay operation is such that Q38 conducts. When Q38 conducts Q44 conducts and current will flow through Q44 and R54 to terminal Z of J14-B. This terminal is connected to terminal 8 of J15-A and is the charging source for the delay timing condensers. Calibration controls for the delay ranges are R51 through R56. The width calibration controls are R82 through R87 and the operation is identical to the delay.

Module A6 also contains the decoding and control circuitry associated with internal-external trigger, gate mode, Pulse-Pair mode and amplitude multiplier. These circuits are shown on schematic 30-02-2. It will also be necessary to refer to Pulse Former schematic 30-01 during the following discussion.

Assume remote operation and Pulse-Pair mode not programmed. Terminal 14 of J14-A is connected to terminal 2 of J15-B. Under the specified conditions Q74 is conducting and Q76 is not. Terminal 14 is always positive and Q11 of pulse former module is conducting disconnecting CR7. With

Pulse-Pair mode programmed Q74 is non-conducting. Q75 conducts only if synchronous gate mode is programmed. If synchronous gate node is programmed Q78 is non-conducting which causes Q75 and Q79 to conduct. Both Q76 and Q80 are non-conducting and terminals 10 and 14 of J14-A are positive. Terminal 10 is connected to terminal 1 of J15-B and when positive Q12 on the Pulse Former module conducts disconnecting CR8. When in asynchronous gate mode no repetition rate triggers can occur until the negative gate signal from input connector J5 is present at terminal X of J14-A. This gate signal turns Q75 and Q79 off during the gate interval and removes the inhibit on the delay and width triggers.

A similar operation occurs if synchronous gate or external trigger is programmed. Terminal 15 of J14-A is connected to terminal C of J15-B. When this line is positive the repetition rate oscillator is inhibited. With external trigger programmed Q87 conducts holding Q84 off. When synchronous gate is programmed Q83 conducts holding Q84 off except during negative gate interval.

The amplitude multiplier program information controls Q89 and Q92. With range 0 programmed both Q89 and Q92 are conducting and Q90 and Q93 are non-conducting. With range 1 programmed Q89 is turned off but Q90 cannot conduct since Q92 is conducting and the collector of Q89 is clamped by diode CR54. With range 2 programmed Q93 conducts and an attenuator in the pulse output is removed by activating a relay. With range 3 programmed both Q90 and Q93 conduct and a second attenuator is removed by activating another relay. The relays and attenuators are located on module A9 schematic 30-12.

3.4 MODULE A4 D/A VERNIER 900A3004C1 (30-03)

Module A4 receives program information regarding the significant figures of repetition rate, delay and width. Consider the repetition rate circuitry. The least significant figure program status is received on the terminals associated with Q25. (4 and D of J12-A) Assume this figure not programmed. Q12 is conducting and CR15 is back biased and current does not flow through the diode. Assume this significant figure of repetition rate is programmed. Q25 conducts causing Q12 to turn off and current will flow from the negative voltage supplied on terminal F of J12-A through R12, R13 and CR15 to terminal H of J12-A. The negative voltage at terminal F is controlled by the repetition rate range circuitry of module A6. Terminal H of J12-A is connected to terminal 21 of J15-A and is the source of the discharge current for the repetition rate timing capacitors. Resistors R1 through R11 are inserted in parallel as other significant figures of repetition rate are programmed. These resistors have a weight ratio corresponding to BCD 1, 2, 4, 8 code and the current is increased as a

function of these resistors. Transistor Q13 is required in the most significant figure because of drive requirements. The delay and width circuits are identical to the repetition rate except for two things. A common fixed negative supply is used, (terminals Z of J12-A and P of J12-B are connected.) and the current modes at the junction of diodes CR41 through CR52 and CR78 through CR89 are converted to voltages at terminals 1 and T of J12-B. These voltages determine the point at which the delay and width charge cycles terminate. R125 and R124 are calibration controls for the low end of the delay and width ranges.

3.5 A2 - REGULATED POWER SUPPLY 900A3008C1 (30-08)

This module contains the ground based power supply regulators. All the supplies are conventional and are not discussed in detail. The negative supply for the repetition rate D/A converter requires an explanation to complete the operation of repetition rate calibration. The output from the programmed range calibration controls at terminal A of J14-A is coupled to terminal J of J10-B. This input current modifies the repetition rate negative voltage regulator and the voltage is adjusted for each individual range. The negative voltage at terminal L of J10-B is coupled to terminal F of J12-A module A4.

3.6 MODULE A10 - OUTPUT 900A3006C1 (30-06)

Module A10 is referenced to a floating ground and care must be exercised the floating ground is not connected to chassis ground by improper use of scopes or other test equipment. Serious damage can result.

The output from the Pulse Former module A7 is coupled to the Output module A10 on terminals F and J of J17-A. Q1 and Q2 drive isolation pulse transformers T1 and T2 and the differentiated signal triggers the input multivibrator Q5 and Q6. The pulse out of the multivibrator has all the characteristics of the pulse developed in the Pulse Former except it is now referenced to a floating ground. The circuitry consisting of transistors Q7, Q8, Q9, Q10 and Q43 with associated components provides a duty cycle limitation in case a stop pulse is not received during initial turn-on or because of some malfunction. In the pulse on condition Q5 and Q9 conduct and Q6 and Q10 are non-conducting. C3 will charge through R15 until Q7 conducts and sets the input multivibrator to the pulse off state. C3 then discharges through Q8 and Q43. The time constant of R15 and C3 is set for approximately 20 milliseconds or twice the maximum programmable width.

When a start signal is received the base of Q6 goes positive. This signal is coupled through R20 to the bases of Q16 and Q17. Simultaneously the negative going signal from

the base of Q5 is coupled through R19 to the bases of Q11 and Q17. Q11 and Q16 constitute a differential amplifier which isolates the rise time circuitry from the input multivibrator. Q17 and Q19 constitute a differential amplifier which isolates the fall time circuitry from the input multivibrator. When the start signal arrives Q16 conducts and Q18 turns off. When Q16 conducts Q14 conducts and Q13 turns off. In addition Q17 conducts and Q21 turns off. The current from the current source Q15 now flows through Q14 to the rise and fall timing condensers. Assuming the rise/fall range programmed is 0 the timing capacitor is the stray capacity at the collector of Q14. As longer ranges are programmed condensers C10 through C14 are added. The charge current is controlled in module A11 by inserting precision resistors in series with the line into terminal 7 of J17-A and the +16 volt floating supply. The voltage on the timing capacity continues to rise until caught by hot-carrier diode CR8. The point at which this clamp occurs is adjusted by R27 and is set to provide proper drive to the output transistors.
Note that the pulse width must be greater than the rise time or full pulse amplitude will not be achieved.

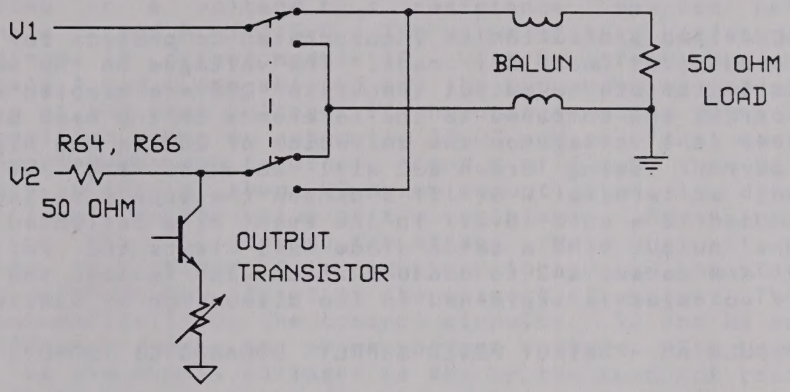
The timing capacitor remains at this preset clamp voltage until the end of the pulse. At this time Q21 conducts and Q14 turns off. The current that was flowing through Q14 now flows through Q13 and CR8 is back biased. The timing condenser now discharges through Q21 and current source Q22 at a rate determined by the fall time control module A11. Precision resistors are inserted in series with the line into terminal 16 of J17-A and the negative 8 volt floating supply. The timing condenser will continue to discharge until caught by hot-carrier diode CR9. Note that the circuit generates rise and fall times not slope.

The output from the rise/fall circuitry is coupled through emitter followers Q26 through Q29 to the output transistor Q30. The constant amplitude pulse drives the base of Q30. To compensate for the base emitter characteristics of the drive transistors which reflects as a load of the timing condenser a feedback resistor R51 causes the current to increase as the voltage on the emitter of Q27 rises. C15 and R50 add compensation for fast rise and fall. Q24 compensates for variations of gain with temperature.

The output amplitude is varied in accordance with the programmed information by changing the resistance in the emitter of the output transistor Q30. Since the base is driven by a fixed amplitude pulse the output current will increase as the emitter resistance is lowered. As significant figures of amplitude are programmed, transistors Q33 through Q41 will conduct inserting additional emitter resistors. Q31 through Q41 are controlled by module A13. To compensate for the base-emitter characteristics of the output transistor the

insertion of the emitter resistors is detected at terminal K of J17-B and used to modify the +8 volt supply and thus maintain amplitude linearity.

The basic output circuitry is illustrated in the simplified diagram below.



Baseline offset is developed by making V1 not equal to V2. Current will then flow from one voltage point to the other. If the internal and external resistors are equal the voltage across each resistor is the same and the polarity is dependent on the relationship of V1 to V2. A 10 volt differential between the two resistors results in a 5 volt offset at the load resistor. The offset current does not flow through the output transistor. With a high impedance load 10 volts of offset would be obtained. Offset to 20 volts into a high impedance can be obtained.

The output pulse is developed when current is drawn through the output transistor Q30. The current through Q30 is determined by the emitter resistors represented by the variable resistor in the diagram. Assume V1 = V2 and 400 ma of current drawn through Q30. The transistor looks into a 25 ohm load and the current will divide equally through the internal and external load resistors developing a 10 volt pulse across the load. With a high impedance load a 20 volt

pulse can be obtained. Specified accuracies apply only with a 50 ohm termination. The difference between the two voltages is controlled by program information in module A13.

Since the output power supplies are floating the system can be grounded at the balun. The balun allows the negative going pulse of the output to be inverted to a positive pulse at the output connector. The several hundreds of picofarads of stray capacity between chassis ground and floating ground would degrade the output except for the compensation provided by the balun. The balun looks like a short length of coax to the pulse and an inductance to the power supplies which reduces the capacitor currents to a negligible amount.

Overload protection is incorporated to protect for worse case conditions under all loads. The voltages on the emitter and collector of the output transistor Q30 are sampled at the base of Q31 and compared to the reference on the base of Q32. Whenever the voltage on the collector of Q30 is too high for the current being drawn Q32 will conduct. The resulting current at terminal W of J17-B causes the supply voltage to be reduced to a safe level. In the event of a reflected pulse on the output line a catch diode CR11 clamps the reflected pulse and causes Q42 to conduct which also reduces the power supply voltages as explained in the discussion of module A8.

3.7 MODULE A8 - OUTPUT POWER SUPPLY 900A3007C1 (30-07)

This module contains 5 regulated power supplies. Three of these supplies (+8v, +16v, -8v) are the supplies for the pulse shaping circuits and the other two (V1, V2) are for the output circuits.

Zener diode CR16 establishes the reference voltage for the +8volt supply. R51, R52, and CR15 provide a start up voltage to insure that the supply not hang up during turn on or after a momentary power failure. Q28 and Q29 constitute the differential amplifier that controls the voltage at the emitter of Q31. This voltage is adjusted by R60. Terminal A of J16-A is returned to terminal K of J17-B which is the sense point for amplitude programming. As the voltage at terminal A varies the output at the emitter of Q31 will vary and maintain amplitude programming linearity. R59 adjusts the amount of compensation.

The +8 volt supply is the reference for the +16 volt supply Q24 through Q27 and associated circuitry. Q24 and Q25 constitute the differential amplifier which controls the +16 volt output. Since the +16 and the -8 volt supplies control the rise and fall times of the output pulse it is necessary that these voltages track. The +16 volt supply is slaved to the -8 volt supply through Q36 and is maintained the same amount above the +8 volt supply as the -8 volt supply is below floating ground. The -8 volt supply consists of Q32 through Q35 and associated circuitry. The -8 volt supply is

referenced to floating ground. R50 and R63 cause the supplies to track variations at terminal A. R70 adjusts the voltage of the -8 and +16 volt supplies.

The output supplies V1 and V2 are source-sink type. The reference voltage for V2 is established on the base of Q13. Q13 and Q14 constitute the differential amplifier associated with V2. The base of Q14 is returned through equal precision resistors to both V1 and V2. Q3 and Q4 constitute the differential amplifier associated with V1. To develop, offset between the two supplies an offset current is coupled into the junction at the base of Q3. The direction of current flow is determined by the state of K1. This offset current is converted to a voltage by a resistance inserted between terminals A and N of J16-B. The value of this resistance is determined in offset module 13. With no offset programmed terminals A and N are shorted and the two supplies are slaved and are at the same voltage. If the offset polity relay is in the position shown on schematic 30-07 and an offset resistor is inserted between terminals A and N of J16-B, then V1 will be more positive than V2 by an amount that is directly proportional to the value of the resistance. Reversing the state of K1 will reverse the offset. Note that if pulse polarity is reversed it is necessary to reverse the state of K1 to maintain the offset in the correct direction. This is done automatically by the control circuits. R2 and R5 adjust the offset currents for proper offset voltage. The average value of the supply voltages is set by the feedback ratio at the base of Q14. When the programmed value of pulse amplitude is less than one volt transistors Q20 through Q23 are non-conducting and the feedback ratio is 2.5 to 1. These transistors are the activated as the programmed pulse amplitude is increased and resistors are added with a 1, 2, 4, 8 weight to change the feedback ratio and increase the average supply voltage in accordance with the programmed demand.

The overload signal developed at terminal W of J17-B is coupled to terminal U of J16-B. When this signal goes positive Q11 conducts discharging C4 and Q12 conducts reducing the reference voltage and lowering the output voltage. The second overload signal developed on terminal U of J17-B is coupled to terminal V of J16-B. When this signal goes positive it drives the base of Q14 and reduces the output voltage. Diodes CR11 and CR12 are incorporated to protect the supplies if module A13 is removed.

3.8 MODULE A13 OFFSET/AMPLITUDE CONTROL 900A3004C1 (30-04)

Program data for significant figure of baseline offset is received on the input lines associated with transistor Q1 through Q16. When an offset is programmed the associated relay K1 through K8 is de-energized and precision resistors are inserted between terminals A and B of J20-A. These terminals are connected between voltage outputs V1 and V2 of

the output power supply terminals A and N of J16-B. The resistors associated with the least significant figures of offset are inserted with a 1, 2, 4, 8 weight and the most significant figures are inserted with a 1, 2, 4, 2 weight. The maximum programmable offset is 10.5 volts.

Program data for significant figure of pulse amplitude is received on the input lines associated with transistors Q24 through Q47. When pulse amplitude is programmed the associated relay K9 through K16 is energized. This applies a positive voltage on the associated line (2, 3, 5, 7, 10, 13, 16, 17) of J20-A. These outputs cause the program resistors to be inserted in the emitter of the output transistor and the current is increased proportionately. The least significant figures of amplitude are inserted with a 1, 2, 4, 8 weight and the most significant figures with a 1, 2, 4, 2 weight. The maximum programmable pulse amplitude is 10.5 volts.

Pulse and offset polarity information is coupled into module A13 on input lines associated with transistors Q17 and Q20. When offset polarity is programmed negative Q21 is non-conducting. When pulse polarity is programmed negative Q18 is non-conducting. With Q18 off, Q19 conducts regardless off programmed offset polarity. To illustrate the operation assume negative pulse and offset polarity. Q18 and Q21 are non-conducting and the junction of CR25 and CR26 is high and Q19 and Q23 are conducting. If offset polarity is changed Q21 conducts and the junction of CR25 and CR26 is low. Q22 is conducting because of the drive through R37 so Q23 is non-conducting and the offset relay reverses. Assume that pulse polarity instead of offset had been changed. Q18 would conduct and the junction of CR25 and CR26 would go low. Q22 would remain conducting because of the drive through R43 and the offset relay would again reverse as required to maintain correct offset and pulse polarity.

The amplitude range information is coupled into module A13 on the input lines associated with Q51. With 0 range programmed Q52 conducts and closes relay K1 on module A10 and inhibits the output pulse. With ranges 1, 2 or 3 programmed Q52 is non-conducting.

3.9 MODULE A11 RISE/FALL CONTROL 900A3005C1 (30-05)

The significant figure program information for rise time is coupled into module A11 on the input lines associated with transistors Q1 through Q16. As rise time is programmed resistors ore inserted in the line between terminals A and B of J18-A. This is the source of the charging current for the rise time circuitry of module A10. Transistors Q28 through Q43 with relays K9 through K16 perform the same function in the fall time circuit. The program information for selecting the range of Rise/Fall is coupled into module A11 on the

input lines associated with transistors Q17 through Q22. The BCD inputs are converted to decimal equivalents and the desired range is selected. Transistors Q23 through Q27 are the range drive transistors.

3.10 MODULE A9 ATTENUATOR 900A3022X1 (30-22)

This module contains the pulse polarity relay K1, the Balun B1 and the two amplitude attenuators.

3.11 MODULE A14 UNREG. POWER SUPPLY 900A3021X1 (30-21)

This module contains the transformers, rectifiers and filters required in the various unregulated voltage sources.

3.12 MODULES A5, A12 MEMORY LATCH 900A3009C1 (30-09)

These modules contain the memories required for the various remote programmed functions. Each memory is selected by first a function address, then a significant figure address, then the programmed value. Module A5 controls repetition rate, delay and width. Module A12 controls risetime, falltime, amplitude, offset and polarity.

3.13 MODULE A3 IEEE CONTROL 900A3023X1 (30-23)

This module interfaces the IEEE commands with the PX32 circuitry. Integrated circuits I5, I2 and I1 decode characters @ through I. Only upper case letters are decoded. Integrated circuits I5, I3, and I4 decode the numbers. Upon receipt of an address Pin 15 of I4 is active and the first number received will be stored in the memory associated with the most significant figure. I3 then steps one and the next number will be stored in the memory associated with the second significant figure. This continues as long as a string of numbers is received up to a maximum of eight. The selected output from I1 (@ through I) determine which memory is used to store the numerical information.

When the PX32 is addressed, the data is accepted by integrated circuits I9 and I10 and latch I12 is activated. This places the instrument in the listen addressed state and indicator light on the front panel will illuminate. This is driven from Pin 19 of J11-B. The second latch places the unit in remote operation by setting Pin 22 of J11-B high disconnecting the front panel switches and activating the remote memories.

One section of I13 is used to clear the listen addressed state if interface clear is received on Pin 14 of J11-B or power is first applied to the unit. The various commands, Group Execute Trigger (GET), Selected Device Clear (SDC), Device Clear (DCL), Go To Local (GTL), Unlisten (UNL) and Local Lock Out (LLO) are decoded by integrated circuits I14,

I16 and I17 and associated elements. The third latch section of I12 is used in local lock out state to inhibit the selection of local operation with the front panel switch. An indicator light on the front panel illuminates when in remote operation.

One special feature is included to prevent undesired pulses from being applied to a unit under test while the program is being changed. Receipt of any address character @ through ? causes the output to be inhibited by the output from Pin H of J11-B. Output is also inhibited by the receipt of SDC or DCL. After receipt of SDC or DCL a command GET is required to turn the output back on. After receipt of a character an ASCII character X is required to turn the unit back on. In certain conditions both GET and X are required.

3.14 INTERFACE MODULE 900A3024X1 (30-24)

This module interfaces the IEEE-488 program bus and the PX32 control module. The DAV pulse is developed on this module in I6 and I7.

SECTION IV

MAINTENANCE

4.1 PREVENTIVE MAINTENANCE

Preventive maintenance on a regular basis helps prevent instrument failure and improves both electrical and mechanical reliability. Preventive maintenance consists of cleaning and visual inspection. Cleaning should be performed as often as operating conditions dictate. Dust accumulation should be blown off with a stream of low velocity dry air. A mild solution of water and detergent may be used on both interior and external surfaces. CAUTION: Plastic materials should not be cleaned with chemical solvents. The PX32 should be inspected for possible defects such as frayed cables or heat damaged components. Corrective procedures are obvious. In the case of heat damaged components an investigation should be made to determine the cause. Fan failure etc.

4.2 CORRECTIVE MAINTENANCE

If apparent trouble develops in the pulse generator first check the settings of the front panel controls or the remote program to make sure the apparent trouble is not the result of improper programming. If an external trouble is being applied check to make sure the signal is reaching the proper input and is of proper amplitude and polarity. If all control settings are correct but the generator does not operate properly some part of the system may be out of calibration or a circuit failure has occurred.

A calibration procedure is provided in Section VI of this manual. Only the section or sections that are out of calibration should be recalibrated. Tri-Phenix recommends a one year calibration cycle. Periodic performance checks should be made to assure proper operation.

If instrument failure occurs corrective maintenance should be performed by qualified personnel or returned to Tri-Phenix for repair. Section V provides trouble shooting procedures. Reference to the sections of the manual describing circuit operation, schematics, parts lists and layout drawings should supply sufficient information to locate and repair the trouble. Parts may be ordered from the parts lists or equivalent components may be used.

SECTION V

TROUBLESHOOTING

5.1 PROCEDURE

The following information is intended as a aid in locating and correcting failures. If an apparent trouble exists:

a. Confirm the trouble exists. Check program.
b. Isolate the trouble to a module. Insert other modules if available.
c. Isolate the trouble to circuit. Table 5-1 relates certain specific troubles and their possible causes. Refer to schematics and circuit description as references.

TABLE 5-1

TROUBLE SHOOTING

REPETITION RATE CIRCUITS

SYMPTOMS	POSSIBLE CAUSES
1. Repetition Rate incorrect on Range 0.	A. Check Q9 and Q15 on module A6. B. Check C5 and K2 on module A7. C. Check setting of R20 on module A6. Calibration section Para. 6.2.b.2.
2. Repetition Rate incorrect on Range 1.	A. Check if both local & remote fail B. If remote only check Q1 module A6 C. If both, check Q10 and Q16 on A6. Check C6 and K3 on A7. Check R21 setting. Calibration Para 6.2.b.3
3. Repetition Rate incorrect on Range 2.	A. Check if both local & remote fail B. If remote only check Q2 module A6 C. If both, check Q11 and Q17 on A6. Check C7 and K4 on A7. Check R22 setting. Calibration Para 6.2.b.4
4. Repetition Rate incorrect on Range 3.	A. Check Q12 and Q18 on module A6. B. Check C8 and K5 on module A7. C. Check R23 setting on module A6. Calibration Para. 6.2.b.5
5. Repetition Rate incorrect on Range 4.	A. Check if both local & remote fail B. If remote only check Q3 on A6. C. If both, check Q13 & Q19 on A6. Check C9 on A7. Check setting of R24 on A6. Cal. Para 6.2.b.6
6. Repetition Rate incorrect on Range 5.	A. Check Q14 & Q20 on module A6. B. Check Q16,K6 & C10 on module A7. C. Check setting R25 on A6. Calibration Para 6.2.b.7
7. Repetition Rate incorrect on Ranges 0 and 1.	A. Check Q7 on module A6.
8. Repetition Rate incorrect on Ranges 2 and 3.	A. Check Q8 on module A6.
9. Repetition Rate incorrect on Ranges 4 and 5.	A. Check Q5 and Q6 on module A6.
10. Repetition Rate incorrect on Range 1, 3 & 5.	A. Check Q4 on module A6.
11. Repetition Rate incorrect on Range 0,1,2 & 3.	A. Check Q5 on module A6.
12. External Trigger inoperative.	A. Check if both remote & local fail B. If remote only check Q85 on A6. C. If both check Q1,Q13,Q14,K1 on A7 Check Q86,Q87 & Q84 on module A6.
13. Synchronous Gate inoperative.	A. Check if both remote & local fail B. If remote only check Q81 on A6. C. If both check Q1 on module A7. Check Q82,Q83 & Q84 on module A6.
14. Asynchronous Gate inoperative.	A. Check if both remote & local fail B. If remote only check Q77 on A6. C. If both check Q78,Q79,Q80 on A6.
15. Repetition Rate incorrect on Most Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q14 on A4. C. If both check Q1 & Q13 on A4.
16. Repetition Rate incorrect on Most Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q15 on A4. C. If both check Q1 & Q13 on A4.
17. Repetition Rate incorrect on Most Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q16 an A4. C. If both check Q3 on A4.

18. Repetition Rate incorrect on Most Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q17 on A4. C. If both check Q4 on A4.
19. Repetition Rate incorrect on 2nd Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q18 on A4. C. If both check Q5 on A4.
20. Repetition Rate incorrect on 2nd Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q19 on A4. C. If both check Q6 on A4.
21. Repetition Rate incorrect on 2nd Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q20 on A4. C. If both check Q7 on A4.
22. Repetition Rate incorrect on 2nd Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q21 on A4. C. If both check Q8 on A4.
23. Repetition Rate incorrect on Least Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q22 on A4. C. If both check Q9 on A4.
24. Repetition Rate incorrect on Least Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q23 on A4. C. If both check Q10 on A4.
25. Repetition Rate incorrect on Least Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q24 on A4. C. If both check Q11 on A4.
26. Repetition Rate incorrect on Least Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q25 on A4. C. If both check Q12 on A4.
27. Repetition Rate incorrect on all Ranges. No TO or Output Pulses.	A. Check -35 volt power supply on A2 B. Q13,Q14,Q15,Q16 on A2. Pin J of J10 is normally -22 + or - 3 vdc. C. Check Q2,Q3,Q4 on module A7. D. Check logic supply module A2. Q6 Q7,Q8,Q9,Q10,Q11,Q12 on A2. See Calibration Para. 6.2.a
28. TO sync incorrect insufficient width	A. Check Q5,Q8,Q9 on module A7.

DELAY CIRCUITS

29. Delta Delay incorrect on Range 0	A. Check Q29,Q35,Q41 on module A6. B. Check Q26,C14 & K7 on A7. C. Check R51 on A6. Cal.Para 6.2.c.5
30. Delta Delay incorrect on Range 1.	A. Check if both remote & local fail B. If remote only check Q21 on A6. C. If both check Q30,Q36,Q42 on A6. D. Check C15 on A7 and setting of R52 on A6. Cal. Para 6.2.c.6.
31. Delta Delay incorrect on Range 2.	A. Check if both remote & local fail B. If remote only check Q22 on A6. C. If both check Q31,Q37,Q43 on A6. D. Check C16 & K8 on A7 & setting of R53 on A6. Cal. Para 6.2.c.2.
32. Delta Delay incorrect on Range 3.	A. Check Q32,Q38,Q43 on module A6. B. Check C17 & K9 on A7 & setting of R54 on A6. Cal. Para 6.2.c.7
33. Delta Delay incorrect on Range 4.	A. Check if both remote & local fail B. If remote only check Q23 on A6. C. If both check Q33,Q39,Q45 on A6. D. Check C18 & K15 on A7 & setting of R55 on A6. Cal. Para 6.2.c.8.
34. Delta Delay incorrect on Range 5.	A. Check Q34,Q40,Q46 on module A6. B. Check C19 & K11 on module A7. C. Check setting of R56 on A6. Para. 6.2.c.9.
35. Delta Delay incorrect on Ranges 0 & 1.	A. Check Q27 on module A6.
36. Delta Delay incorrect on Ranges 2 & 3.	A. Check Q28 on module A6.
37. Delta Delay incorrect on Ranges 4 & 5.	A. Check Q25,Q26 on module A6.
38. Delta Delay incorrect on Ranges 1,3,5.	A. Check Q24 on module A6.
39. Delta Delay incorrect on Ranges 0,1,2,3	A. Check Q25 on module A6.
40. Pulse Pair inoperative	A. Check if both remote & local fail B. If remote only check Q73 on A6. C. If both check Q74,Q75,Q76 on A6 & check Q11 on module A7.

41. Delta Delay incorrect on Most Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q39 on A4. C. If both check Q38,Q26 on A4.
42. Delta Delay incorrect on Most Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q40 on A4. C. If both check Q27 on A4.
43. Delta Delay incorrect on Most Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q41 on A4. C. If both check Q28 on A4.
44. Delta Delay incorrect on Most Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q42 on A4. C. If both check Q29 on A4.
45. Delta Delay incorrect on 2nd Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q43 on A4. C. If both check Q30 on A4.
46. Delta Delay incorrect on 2nd Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q44 on A4. C. If both check Q31 on A4.
47. Delta Delay incorrect on 2nd Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q45 on A4. C. If both check Q32 on A4
48. Delta Delay incorrect on 2nd Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q46 on A4. C. If both check Q33 on A4.
49. Delta Delay incorrect on Least Sig.Fig.8	A. Check if both remote & local fail B. If remote only check Q47 on A4. C. If both check Q34 on A4.
50. Delta Delay incorrect on Least Sig.Fig.4	A. Check if both remote & local fail B. If remote only check Q48 on A4. C. If both check Q35 on A4.
51. Delta Delay incorrect on Least Sig.Fig.2	A. Check if both remote & local fail B. If remote only check Q49 on A4. C. If both check Q36 on A4.
52. Delta Delay incorrect on Least Sig.Fig.1	A. Check if both remote & local fail B. If remote only check Q50 on A4. C. If both check Q37 on A4.
53. Delta Delay incorrect all Ranges. Width ok	A. Check setting R125 on A4. Para. 6.2.c.1 thru 4 of calibration. B. Check Q51 on A4.
54. Delay Inoperative	A. Check Q12 & Q17 thru Q25 on A7.
55. Delay & Width incorrect all Ranges.	A. Check -35 volt power supply. Q17, Q18,Q19,Q20 on A2. Pin Z of J10-B normally -35 +or- 3V B. Check Logic Power Supply (6.4v) C. See calibration section 6.2.a

WIDTH CIRCUITS

56. Pulse Width incorrect on Range 0.	A. Check Q55,Q61,Q67 on module A6. B. Check Q37,C22,K12 on module A7. C. Check R82 setting on A6. Para. 6.2.d.4 of calibration section.
57. Pulse Width incorrect on Range 1.	A. Check if both remote & local fail B. If remote only check Q47 on A6. C. If both check Q56,Q62,Q68 on A6. D. Check C23 on A7 and setting of R83 on A6. Cal. Para 6.2.d.5.
58. Pulse Width incorrect on Range 2.	A. Check if both remote & local fail B. If remote only check Q48 on A6. C. If both check Q57,Q63,Q69 on A6. D. Check C24,K13 on A7 & setting of R84 on A6. Cal. Para 6.2.d.1.
59. Pulse Width incorrect on Range 3.	A. Check Q58,Q64,Q70 on A6. B. Check C25,K14 on A7 & setting of R85 on A6. Cal Para 6.2.d.6.
60. Pulse Width incorrect on Range 4.	A. Check if both remote & local fail B. If remote only check Q49 on A6. C. If both check Q59,Q65,Q71 on A6. D. Check C26,K15 on A7 & setting of R86 on A6. Cal. Para 6.2.d.7.
61. Pulse Width incorrect on Range 5.	A. Check Q60,Q66,Q72 on A6. B. Check C27,K16 on A7 & setting of R87 on A6. Cal. Para 6.2.d.8.
62. Pulse Width incorrect on Range 0 and 1.	A. Check Q53 on module A6.
63. Pulse Width incorrect on Range 2 and 3.	A. Check Q54 on module A6.
64. Pulse Width incorrect on Range 4 and 5.	A. Check Q51,Q52 on module A6.

65. Pulse Width incorrect on Ranges 1,3,5	A. Check Q50 on module A6.
66. Pulse Width incorrect on Ranges 0,1,2,3	A. Check Q51 on module A6.
67. Pulse Width incorrect on Most Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q65 on A4. C. Check Q52,Q64 on A4.
68. Pulse Width incorrect on Most Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q66 on A4. C. Check Q53 on module A4.
69. Pulse Width incorrect on Most Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q67 on A4. C. Check Q54 on module A4.
70. Pulse Width incorrect on Most Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q68 on A4. C. Check Q68 on module A4.
71. Pulse Width incorrect on 2nd Sigh. Fig.8	A. Check if both remote & local fail B. If remote only check Q69 on A4. C. Check Q56 on Module A4.
72. Pulse Width incorrect on 2nd Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q70 on A4. C. Check Q57 on module A4.
73. Pulse Width incorrect on 2nd Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q71 on A4. C. Check Q58 on module A4.
74. Pulse Width incorrect on 2nd Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q72 on A4. C. Check Q59 on module A4.
75. Pulse Width incorrect on Least Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q73 on A4. C. Check Q60 on module A4.
76. Pulse Width incorrect on Least Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q74 on A4. C. Check Q61 on module A4.
77. Pulse Width incorrect on Least Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q75 on A4. C. Check Q62 on module A4.
78. Pulse Width incorrect on Least Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q76 on A4. C. Check Q63 on module A4.
79. Pulse Width incorrect on all ranges.	A. Check setting R124 on A4. Refer to Calibration Paragraphs 6.2.d.1 through 4.
80. Pulse Width inoperative.	A. Check pulse width circuits. Q27, Q18-Q23,Q34,Q11 on module A7.
81. Start-Stop pulse incorrect. Pins N or 12 on J15-B.	A. Check Q35 and Q36 on module A7.

RISE/FALL CIRCUITS

82. Rise Time incorrect on Least Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q1 on A11. C. If both check Q2,K1 on A11.
83. Rise Time incorrect on Least Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q3 on A11. C. If both check Q4,K2 on A11.
84. Rise Time incorrect on Least Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q5 on A11. C. If both check Q6,K3 on A11.
85. Rise Time incorrect on Least Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q7 on A11. C. If both check Q8,K4 on A11.
86. Rise Time incorrect on Most Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q9 on A11. C. If both check Q10,K5 on A11.
87. Rise Time incorrect on Most Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q11 on A11. C. If both check Q12,K6 on A11.
88. Rise Time incorrect on Most Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q13 on A11. C. If both check Q14,K7 on A11.
89. Rise Time incorrect on Most Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q15 on A11. C. If both check Q16,K8 on A11.
90. Fall Time incorrect on Least Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q28 on A11. C. If both check Q29,K9 on A11.

91. Fall Time incorrect on Least Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q30 on A11. C. If both check Q31,K10 on A11.
92. Fall Time incorrect on Least Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q32 on A11. C. If both check Q33,K11 on A11.
93. Fall Time incorrect on Least Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q34 on A11. C. If both check Q35,K12 on A11.
94. Fall Time incorrect on Most Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q36 on A11. C. If both check Q37,K13 on A11.
95. Fall Time incorrect on Most Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q38 on A11. C. If both check Q39,K14 on A11.
96. Fall Time incorrect on Most Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q40 on A11. C. If both check Q41,K15 on A11.
97. Fall Time incorrect on Most Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q42 on A11. C. If both check Q43,K16 on A11.
98. Rise Fall incorrect on Range 5	A. Check CR25,CR26,Q23 on A11. B. Check C14,K6 on module A10.
99. Rise Fall incorrect on Range 4	A. Check if both remote & local fail B. If remote only check Q17 on A11. C. If both check Q18,Q24 on A11 and C13,K5 on module A10.
100. Rise Fall incorrect on Range 3	A. Check CR27,CR28,Q25 on A11. B. Check C12,K4 on module A10.
101. Rise Fall incorrect on Range 2	A. Check if both remote & local fail B. If remote only check Q19 on A11. C. If both check Q20,Q26 on A11 and C11,K3 on module A10.
102. Rise Fall incorrect on Range 1	A. Check if both remote & local fail B. If remote only check Q21 on A11. C. If both check Q22,Q27 on A11 and Q23,K2 on module A10.
103. Rise Fall incorrect on all ranges	A. Check setting R70 on A8. Cal. Para.6.2.h. Check -8 volt supply Q32,Q33,Q34,Q35 on A8. B. Check Circuits Q13-Q18,Q20-Q22 on A10.
104. Rise Fall unbalanced.	A. Check setting R47 on A10. Cal. Paragraph 2.6.h. B. Check circuit Q24 - Q26 on A10.

AMPLITUDE CIRCUITS

105. Pulse Amplitude incorrect on Least Sig. Fig.1	A. Check if both remote & local fa B. If remote only check Q36 on A13 C. If both check Q24,Q25,Q26 on A1
106. Pulse Amplitude incorrect on Least Sig. Fig.2	A. Check if both remote & local fa B. If remote only check Q39 on A13 C. If both check Q40,Q41,K14 on A1 Check Q40 and CR19 on A10.
107. Pulse Amplitude incorrect on Least Sig. Fig.4	A. Check if both remote & local fa B. If remote only check Q42 on A13 C. If both check Q43,Q44,K15 on A1 Check Q39 and CR18 on A10.
108. Pulse Amplitude incorrect on Least Sig. Fig.8	A. Check if both remote & local fa B. If remote only check Q45 on A13 C. If both check Q46,Q47,K16 on A1 Check Q38 and CR17 on A10.
109. Pulse Amplitude incorrect on Most Sig. Fig.1	A. Check if both remote & local fa B. If remote only check Q24 on A13 C. If both check Q25,Q26,K9 on A13 Check Q37 and CR16 on A10.
110. Pulse Amplitude incorrect on Most Sig. Fig.2	A. Check if both remote & local fa B. If remote only check Q27 on A13 C. If both check Q28,Q29,K10 on A1 Check Q36 and CR15 on A10.
111. Pulse Amplitude incorrect on Most Sig. Fig.4	A. Check if both remote & local fa B. If remote only check Q33 on A13 C. If both check Q34,Q35,K12 on A1 Check Q33,Q34,CR12,CR13 on A10.
112. Pulse Amplitude incorrect on Most Sig. Fig.8	A. Check if both remote & local fa B. If remote only check Q30 on A13 C. If both check Q35 & CR14 on A10 Check Q31,Q32,CR45,CR46 on A13.

113. Pulse Amplitude incorrect on Range 2	A. Check if both remote & local fail B. If remote only check Q91 on A6. C. If both check Q92,Q93 on A6. Check K3 on A9.
114. Pulse Amplitude incorrect on Range 1	A. Check if both remote & local fail B. If remote only check Q88 on A6. C. If both check Q89,Q90,CR54 on A6. Check K2 on A9.
115. Pulse Amplitude incorrect on Range 0	A. Check if both remote & local fail B. If remote only check Q48,Q51 on A13. C. If both check Q49,Q50,Q52 on A13. Check K1 on module A10.
116. Pulse Amplitude incorrect on all ranges	A. Check setting R59,R60 on A8. Calibration Para. 6.2.e B. Check setting R21 on A8. Calibration Para. 6.2.f C. Check setting R27 on A10. Calibration Para. 6.2.i D. Check Q20,Q21,Q22,Q23 on A8. E. Check Q11-12 on A8,&Q31-32 on A10 F. Check Q28-31 on A8. Fltg 8v power G. Check Q3-10 & Q13-19 on A8. The Output Power Supplies are floating with respect to ground so all measurements are referred to floating ground. Use caution.
117. Pulse Polarity incorrect	A. Check if both remote & local fail B. If remote only check Q17 on A13. C. If both check K1 on A9. Check Q18,Q19,Q20,Q21 on A13.
118. Offset Amplitude incorrect on Least Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q1 on A13. C. If both check Q2,K1 on A13.
119. Offset Amplitude incorrect on Least Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q3 on A13. C. If both check Q4,K2 on A13.
120. Offset Amplitude incorrect on Least Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q5 on A13. C. If both check Q6,K3 on A13.
121. Offset Amplitude incorrect on Least Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q7 on A13. C. If both check Q8,K4 on A13.
122. Offset Amplitude incorrect on Most Sig. Fig.1	A. Check if both remote & local fail B. If remote only check Q9 on A13. C. If both check Q10,K5 on A13.
123. Offset Amplitude incorrect on Most Sig. Fig.2	A. Check if both remote & local fail B. If remote only check Q11 on A13. C. If both check Q12,K6 on A13.
124. Offset Amplitude incorrect on Most Sig. Fig.4	A. Check if both remote & local fail B. If remote only check Q15 on A13. C. If both check Q16,K8 on A13.
125. Offset Amplitude incorrect on Most Sig. Fig.8	A. Check if both remote & local fail B. If remote only check Q13,CR14, CR19,CR20 on A13 C. If both check CR17,CR13,CR18,Q14 K7 on module A13.
126. Offset incorrect on all programs	A. Check settings R2 & R5 on A8. Calibration Para. 6.2.g B. Check Q1,Q2,CR1,CR2 on A8. C. Check CR11,CR12 on A8. D. Check output power supplies.
127. Offset Amplitude incorrect	A. Check if both remote & local fail B. If remote only check Q20 on A13. C. If both check K1 on module A8. Check K1 on module A9. Check Q22,Q23,Q17,Q18 on A13.
128. Excessive Jitter	A. Check all unregulated supplies. B. Check all regulated supplies. C. Check for intermittent.
129. Pulse Shape incorrect	A. Check Rise & Fall circuits. B. Check Q11 through Q30 on A10.

INTERFACE CIRCUITS

130. Unable to Address Unit	A. Check interface cable. B. Check Module A15. I1 through I6. C. Check I9 thru I13 & I7,I15 on A3.
131. Unable to activate remote	A. Check module A15. B. Check I12,Q1,Q2,Q3 etc. on A3.
132. Unable to Program Functions when addressed	A. Check module A15. B. Check I2,I3,I4,I5,I6,I7 on A3. C. Check program. D. Check associated memory A5 or A12

133.	Unable to Program Sig. Fig.	A. Check I1,I2,I5,I7 on A3. B. Check associated memory A5 or A12
134.	Unable to Program Commands	A. Check I8,I14,I15,I16,I17,I13,I12 on A3 according to command. B. Check module A15.

135. General Information. If front panel operation is normal and remote operation fails the problem is most apt to be located in modules A3, A5,A12 or A15. To test these boards access to a computer or test set is required to generate the required signals. Follow logic sequences as indicated on the schematics to check these modules.

SECTION VI

CALIBRATION

6.1 GENERAL INFORMATION

Before any adjustment of the internal controls of the PX32 is attempted, a performance check should be made to determine if any parameters are not within specifications. The equipment used to perform these checks must be capable of making the required measurements. During any check care must be exercised that proper operation is maintained. Improper settings or programs can indicate apparent malfunctions that are only operational error. Only when a parameter is determined to be out of tolerance should adjustments be made. An individual parameter can be calibrated and complete realignment of the unit may not be required.

6.2 CALIBRATION PROCEDURES

The following procedure is arranged in a sequence that allows the PX32 to be calibrated with a minimum of adjustment interaction.

a. Adjust logic power supply A2.
   1. Connect a DC voltmeter between the positive 6.4 volt supply (terminal X of J20-A) and chassis ground.
   2. Adjust R14 On Module A2 for + 6.4 volts.

b. Adjust Repetition Rate.
   In the following steps the most significant figure of repetition rate should be set to 8 and the other significant figures to zero. (800) The trigger mode is internal and the gate mode is off.

   1. Connect a frequency counter to sync output J6.
   2. Program repetition Range 0 and adjust R20 on module A6 for a repetition rate of 80 Hz.
   3. Program Range 1 and adjust R21 for 800 Hz.
   4. Program Range 2 and adjust R22 for 8000 Hz.
   5. Program Range 3 and adjust R23 for 80000 Hz.
   6. Program Range 4 and adjust R24 for 800000 Hz.
   7. Program Range 5 and adjust R25 for 8000000 Hz.
   8. Check all ranges through the significant for linearity and accuracy. If any Range is out of tolerance repeat calibration for that range.

c. Adjust Delta Delay.
   In all the following steps the period of the repetition rate should be at least three times the period of the delay and width combined and the rise

and fall time should be programmed to zero. (Use external trigger if desired) The pulse pair mode switch set to normal and the gate mode switch to off. Program any desired amplitude. The delay is a change in delay and not absolute delay. The T0 sync pulse may be used as a reference. The delay on each range is calibrated by measuring the change in delay on each range from minimum setting of the significant (000) to a setting 900 and adjusting for the correct change. In all steps measure the delay from the leading edge of the T0 sync pulse to the leading edge of the output pulse.

1. Program delay to 0002 and measure delay. This is minimum delay.
2. Program delay 9002 and adjust R53 on module A6 for a change in delay of 9 usec from the reading in 1.
3. Program delay 1002 and adjust R125 on module A4 for a change of delay of 9 usec from the reading in 1.
4. Repeat steps 1, 2 and 3 until both readings are correct.
5. Program delay 9000 and adjust R51 on A6 for a delay of 90 nsec from reading in step 1.
6. Program delay 9001 and adjust R52 on A6 for a delay of 900 nsec from the reading in step 1.
7. Program delay 9003 and adjust R54 on A6 for a delay of 90 usec from reading in step 1.
8. Program delay 9004 and adjust R55 on A6 for a delay of 900 usec from reading in step 1.
9. Program delay 9005 and adjust R56 on A6 for a delay of 9000 usec from reading in step 1.
10. Check ranges through the significant figures for linearity and accuracy. If any range is out of tolerance repeat the calibration. It may be necessary to repeat steps 1, 2 and 3.

d. Adjust Pulse Width.

In all the following steps the period of repetition rate should be at least three times the period of the pulse width. Set delay to 0000, rise and fall to 00000, gate mode off, pulse pair mode normal and amplitude to the desired level.

1. Program width to 9002 and adjust R84 on module A6 for an output pulse width of 9 usec.
2. Program width to 1002 and adjust R124 on module A4 for an output pulse width of 1 usec.
3. Repeat 1 & 2 until both readings are correct.
4. Program width to 9000 and adjust R82 on module A6 for an output pulse width of 90 nsec.
5. Program width to 9001 and adjust R83 on module A6 for an output pulse width of 900 nsec.

6. Program width to 9003 and adjust R85 on module A6 for an output pulse width of 90 usec.
7. Program width to 9004 and adjust R86 on module A6 for an output pulse width of 900 usec.
8. Program width to 9005 and adjust R87 on module A6 for an output pulse width of 9000 usec.
9. Check all ranges through the significant figures for linearity and accuracy. If range is out of tolerance repeat the calibration of that range. It may be necessary to repeat steps 1, 2 and 3.

e. Adjust Output Amplitude.

The output is a floating system. **Do not connect the floating ground to chassis ground.**

Program:
Repetition Rate to 2004.
Delay to 0000.
Width to 1002.
Offset to 00. Polarity negative.
Pulse Amplitude Range 3, pulse polarity positive.
Trigger mode internal.
Gate mode off.
Pulse pair mode normal.
Terminate output in 50 ohms.

1. Program output amplitude to 00390 (9 volts) and adjust R59 on module A8 for an output pulse amplitude on 9.0 volts.
2. Program output amplitude to 00320 and adjust R60 on module A8 for an output pulse amplitude 2.0 volts.
3. Repeat 1 & 2 until both readings are correct.
4. If trouble is encountered see " i " below.

f. Adjust Output Power Supply.

1. Program Amplitude/Offset to 00000.
2. Program offset polarity negative.
3. Program Pulse Output negative.
4. Connect a dc voltmeter between terminals U & T of J17-B, module A10.
5. Adjust R21 on module A8 to a reading of 15 vdc.

g. Adjust Baseline Offset.

1. Terminate output in 50 ohms. At least 2 watts.
2. Program Amplitude/Offset to 90300.
3. Connect a DC voltmeter across the output load.
4. Program Offset and Pulse polarities negative.
5. Adjust R5 on module A8 for a dc output of -9 v.
6. Program offset polarity positive.
7. Adjust R2 on module A8 for a dc output of +9 v.

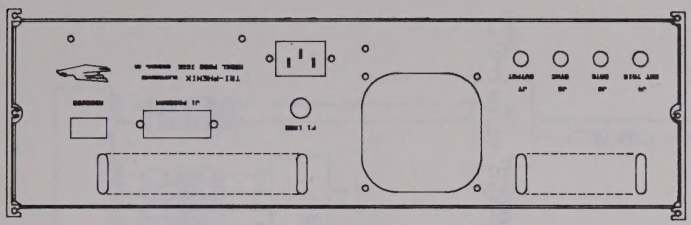
8. If trouble is encountered see " i " below.

h. Adjust Rise/Fall Time.

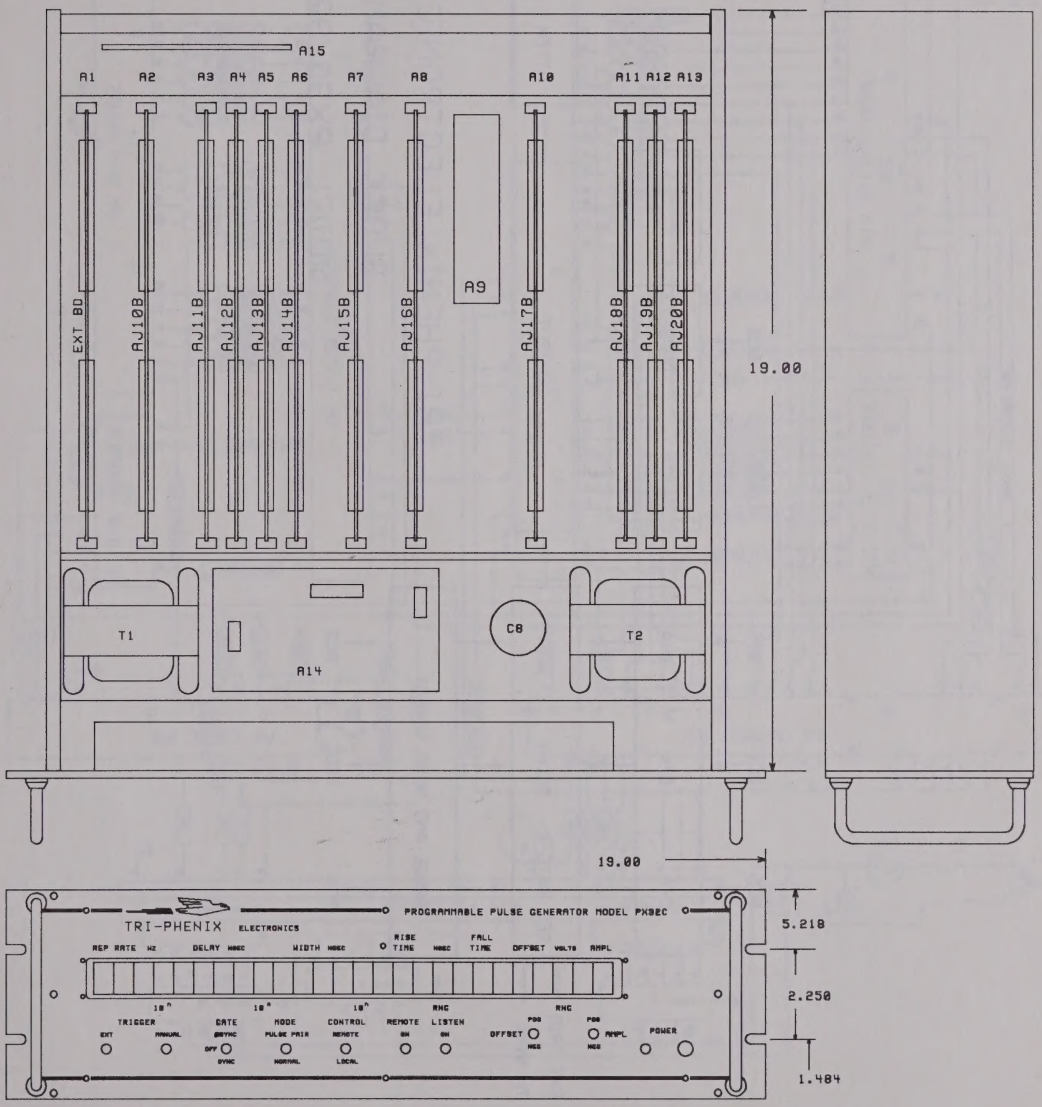
1. Program Rise/Fall to 99299.
2. Program Amplitude/Offset to 00399.
3. Terminate the output in 50 ohms. 2 watt
4. Program the remaining functions so that a 9.9 volt pulse is obtained.
5. Measure the rise and fall times of the output & adjust R47 on module A10 for equal rise and fall times.
6. Measure the rise time of the pulse & adjust R70 on module A8 for a pulse rise time of 9.9 usec between the 10 % and 90 % voltage points of the output pulse.
7. Repeat 5 & 6 until both readings are correct.
8. Check other ranges and significant figures for linearity and accuracy. All should be within specified tolerances.

i. Adjust Pulse Shape.

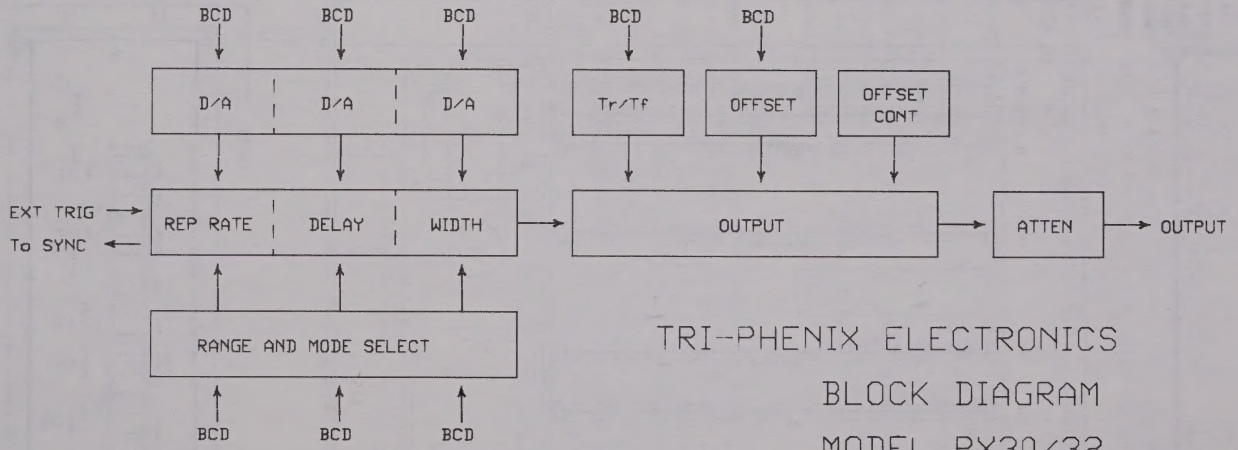
R27 on module A10 affects the pulse shape of the output pulse by setting the clamp voltage. R27 is adjusted to the point where minimum change in pulse shape occurs as the fall time is changed without clamp occurring on the peak of the pulse. If this control is set improperly it will prevent the pulse amplitude from being calibrated at 9.9 volts. Be sure that clamping does not occur. This control is normally near the end of clockwise rotation.



A1	900A3013X1	EXT BD
A2	900A3000C3	LOGIC POWER SUPPLY
A3	900A3023X1	IEEE CONTROL
A4	900A3003C1	D/A VERNIER
A5	900A3009C1	MEMORY LATCH
A6	900A3002C1	D/A RANGE
A7	900A3001C1	PULSE FORMER
A8	900A3007C1	OUTPUT POWER SUPPLY
A9	900A3022X1	ATTENUATOR
A10	900A3006C1	OUTPUT
A11	900A3005C1	RISE & FALL TIME
A12	900A3009C1	MEMORY LATCH
A13	900A3004C1	AMPL/OFFSET
A14	900A3021X1	UNREG POWER SUPPLY
A15	900A3024X1	IEEE INTERFACE



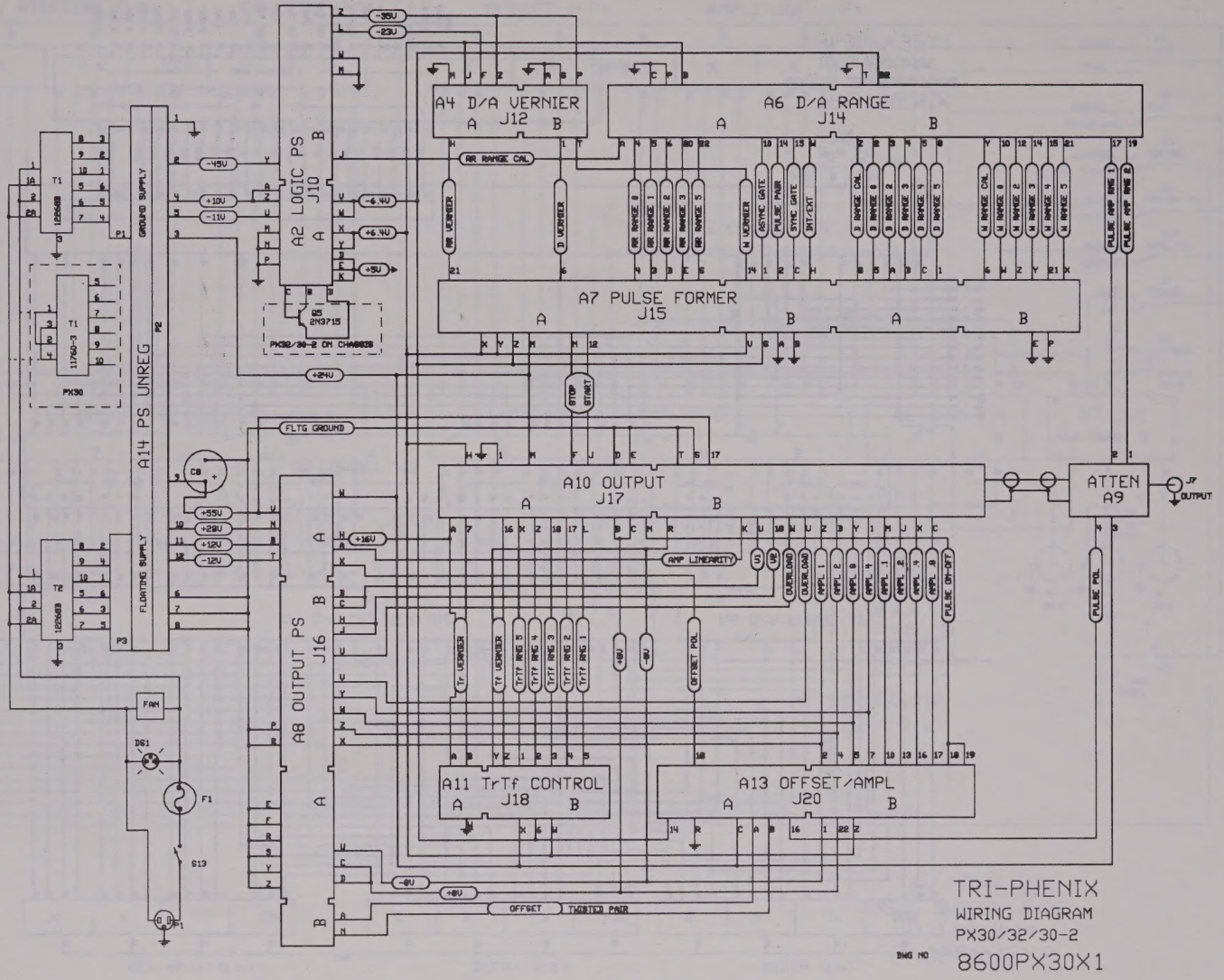
TRI-PHENIX ELECTRONICS
OUTLINE DWG PX32
IEEE PROGRAM



TRI-PHENIX ELECTRONICS

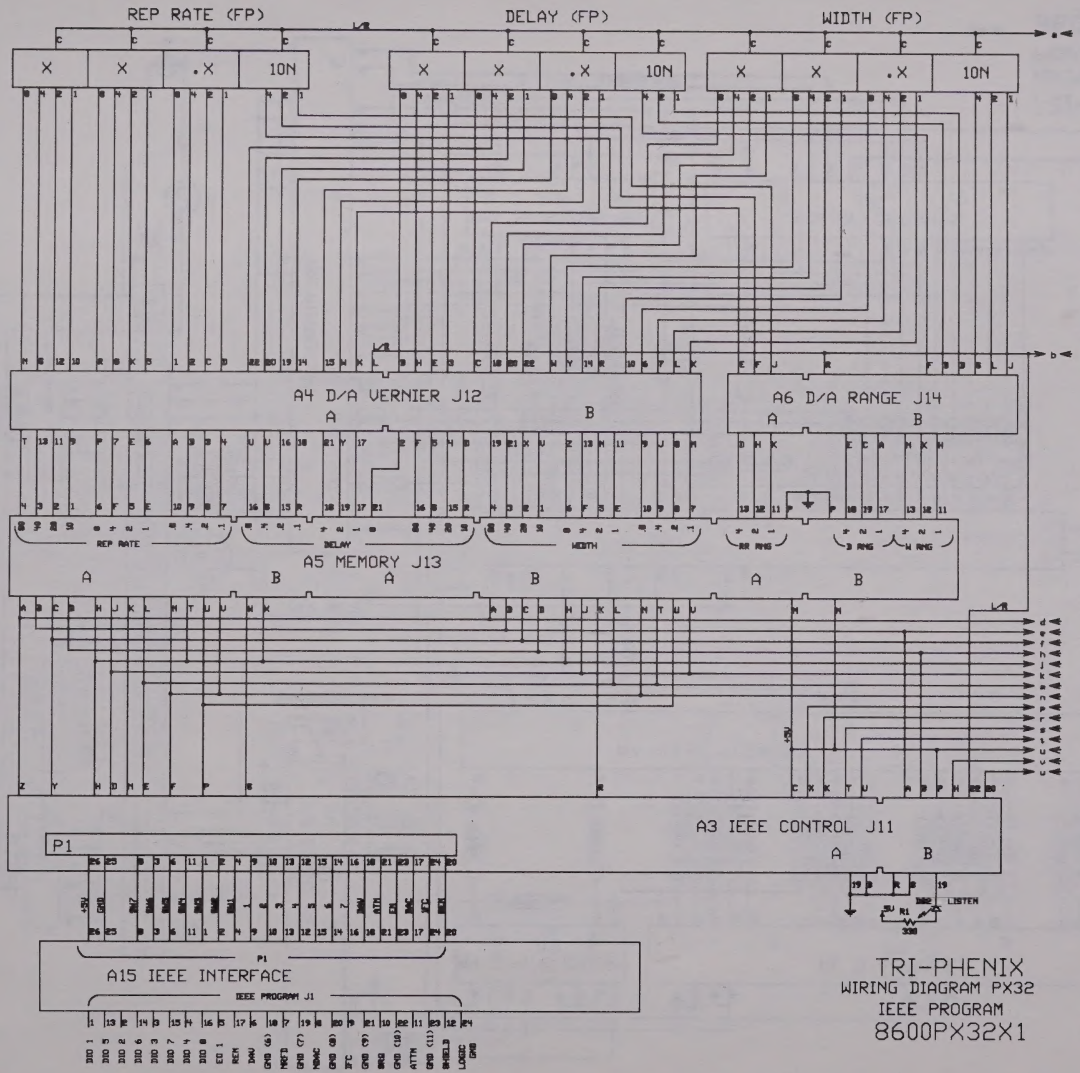
BLOCK DIAGRAM

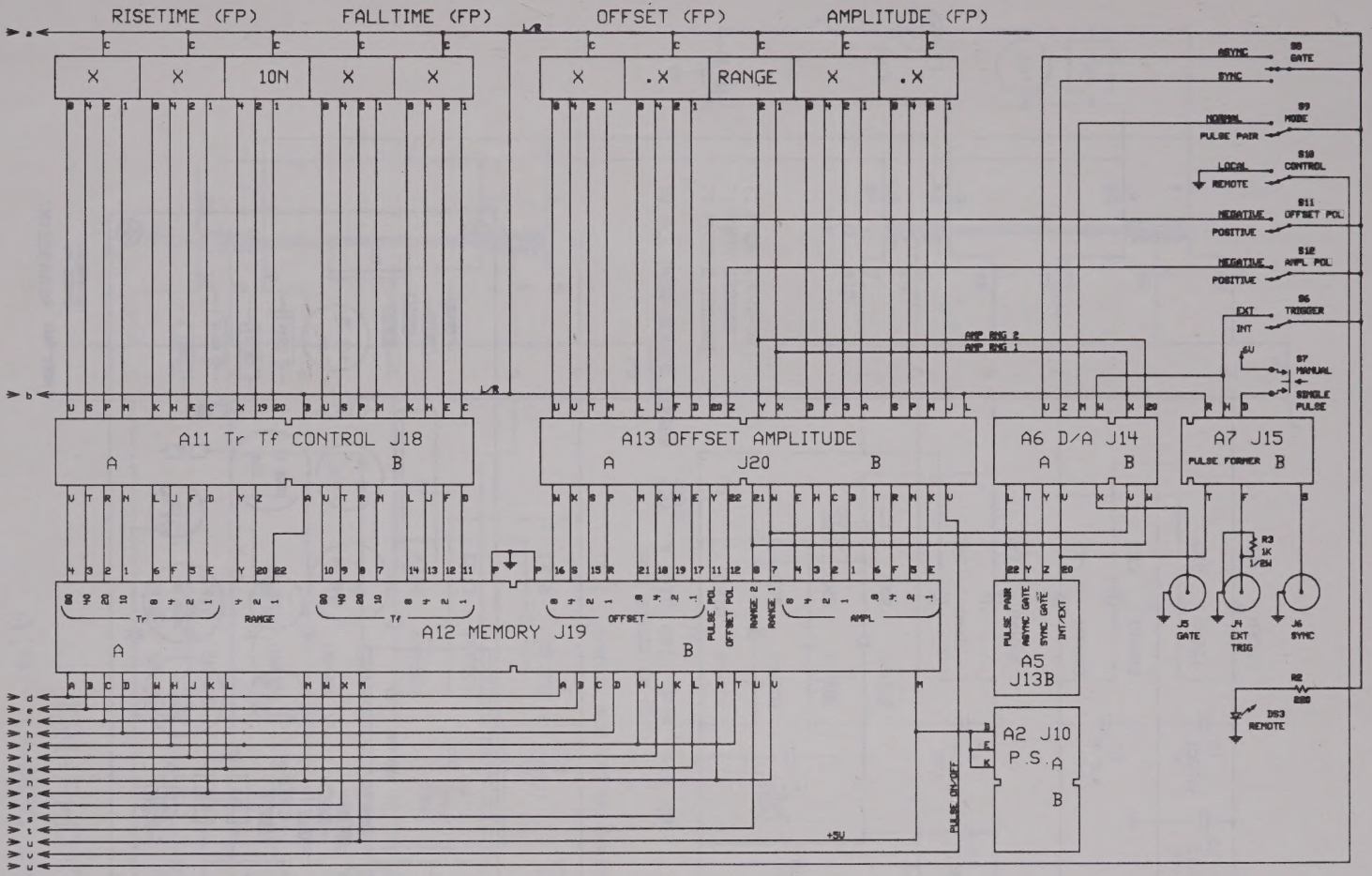
MODEL PX30/32



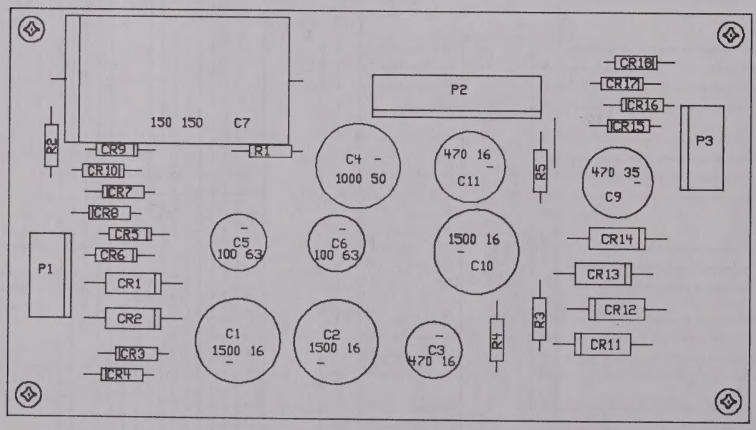
TRI-PHENIX
WIRING DIAGRAM
PX30/32/30-2

DWG NO 8600PX30X1

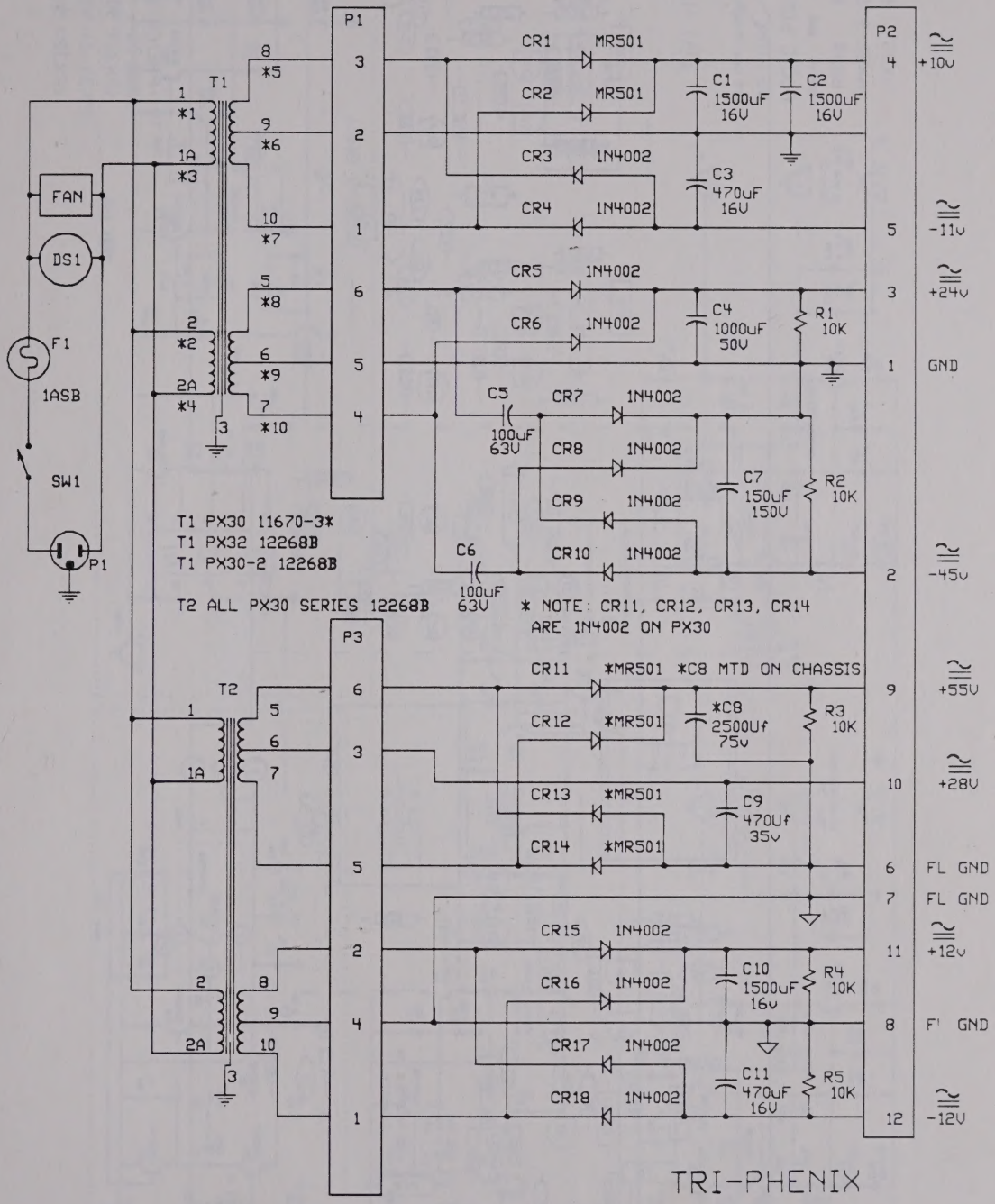

REP RATE (FP)
DELAY (FP)
WIDTH (FP)
X
X
.X
10N
A4 D/A VERNIER J12
A6 D/A RANGE J14
A5 MEMORY J13
REP RATE
DELAY
WIDTH
A3 IEEE CONTROL J11
P1
A15 IEEE INTERFACE
IEEE PROGRAM J1
TRI-PHENIX
WIRING DIAGRAM PX32
IEEE PROGRAM
8600PX32X1



TRI-PHENIX
WIRING DIAGRAM PX32
IEEE PROGRAM
8600PX32X2



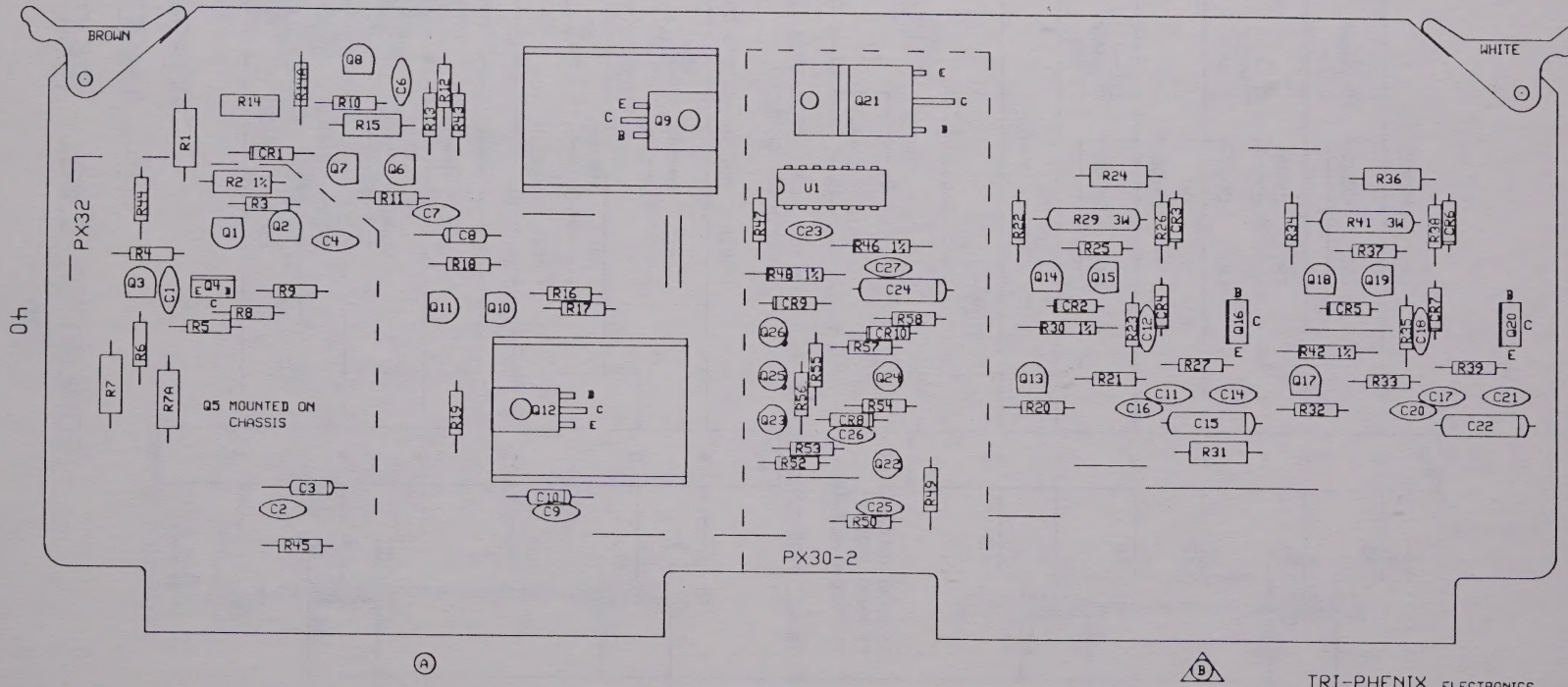
TRI-PHENIX
UNREG PS
ASSY DWG 900A3021X1



TRI-PHENIX

A14 UNREG PS

SCHEMATIC DIAG 860A3021X1



TRI-PHENIX ELECTRONICS

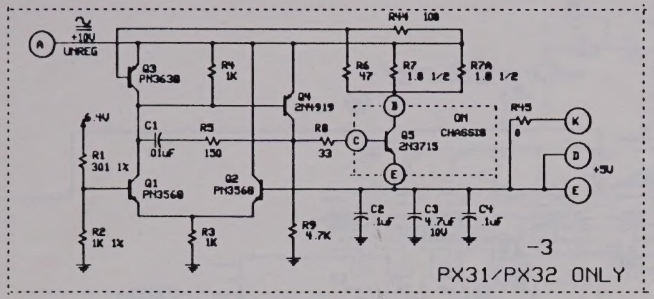
LOGIC PS

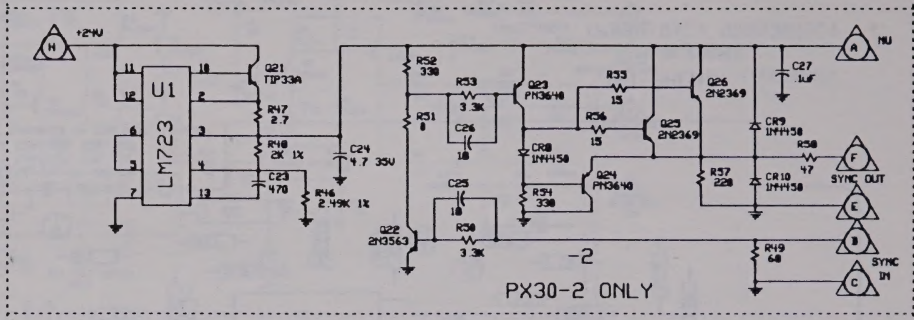
ASSY DWG

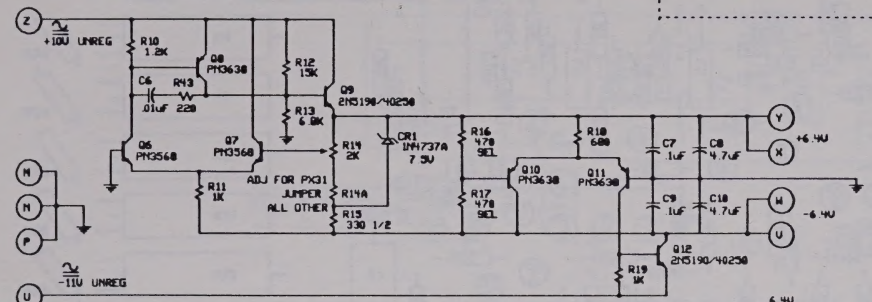
(PX30) 900A0208C1

(PX30-2) 900A3008C2

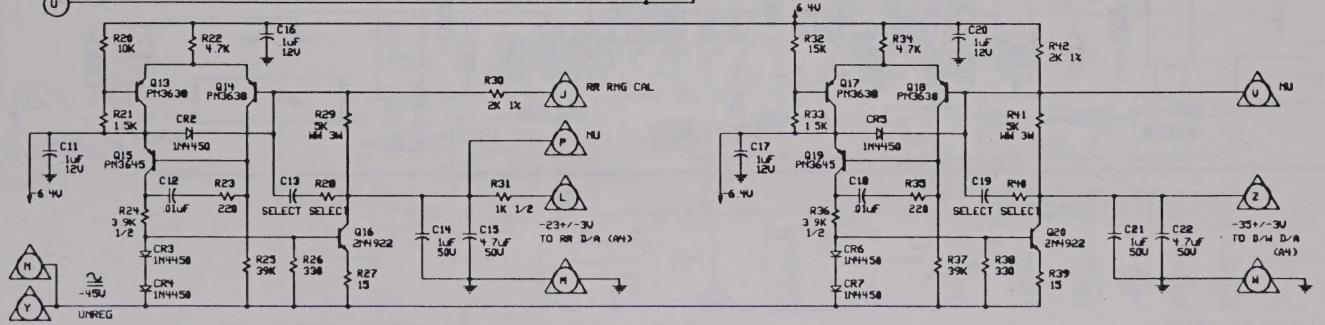
(PX32) 900A3008C3







LAST	SELECT
R50	R51,28,48
Q26	
CR9	
C27	C13,19



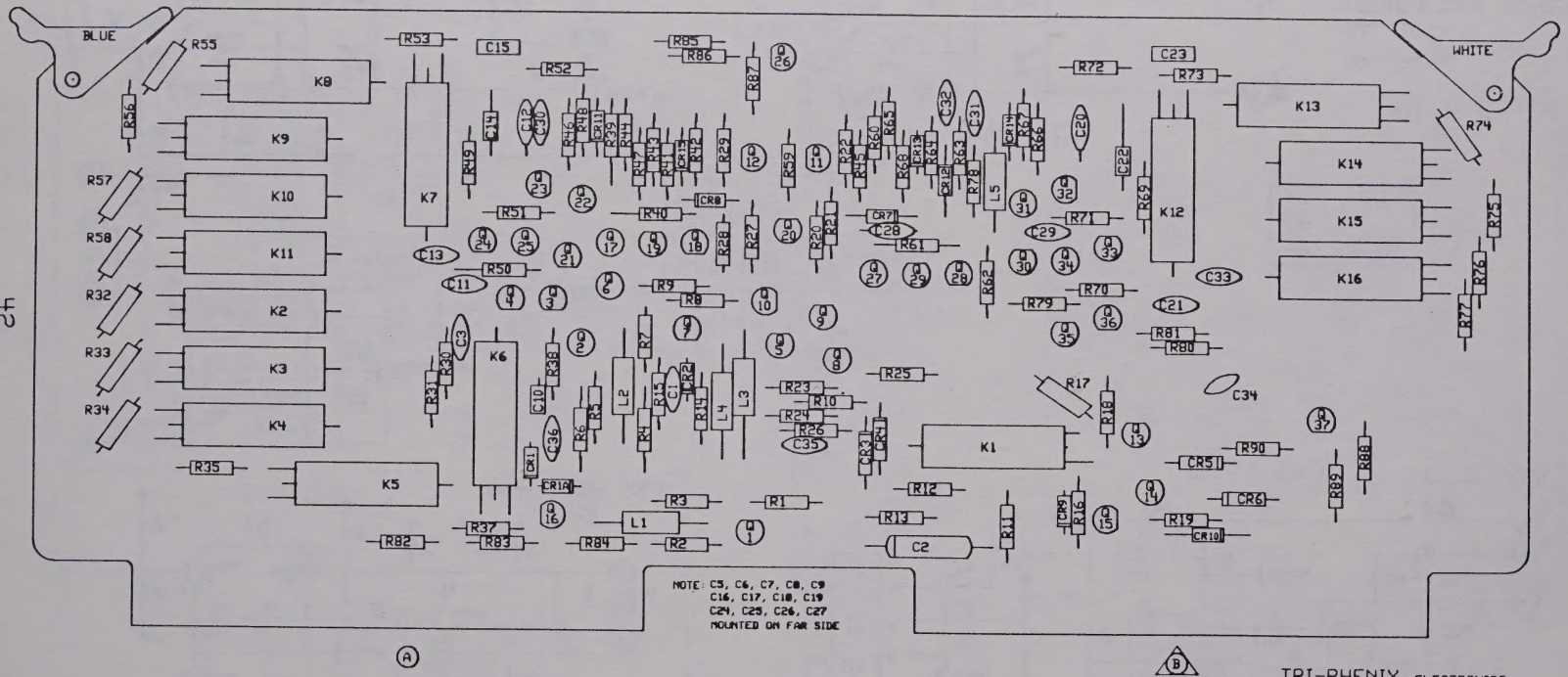
TRI-PHENIX

FILE PX301081.SCH

A2 J10

LOGIC POWER SUPPLY

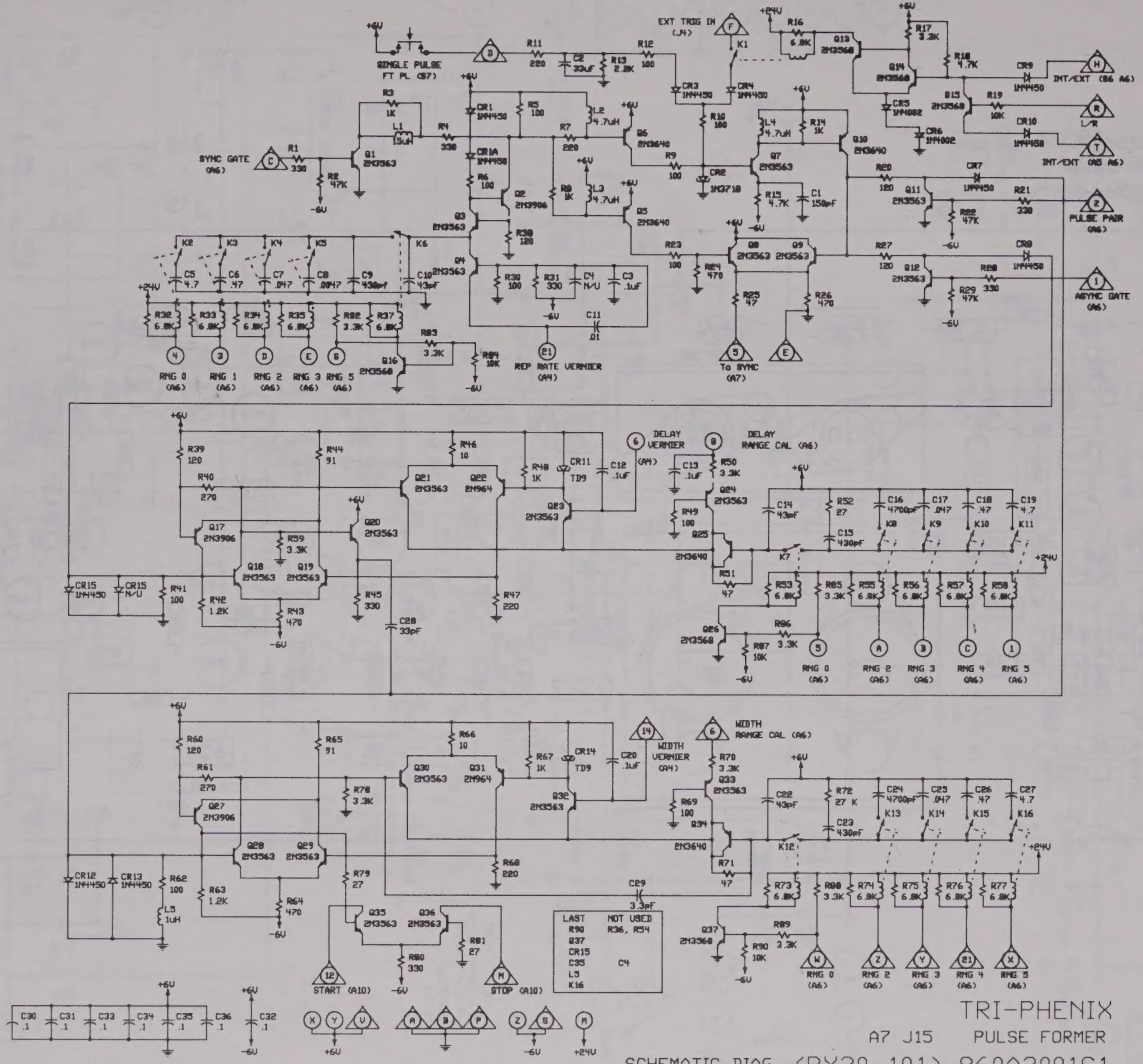
SCHEMATIC DIAG	(PX30-108)
PX30	860A3008C1
PX30-2	860A3008C2
PX32	860A3008C3



TRI-PHENIX ELECTRONICS

PULSE FORMER

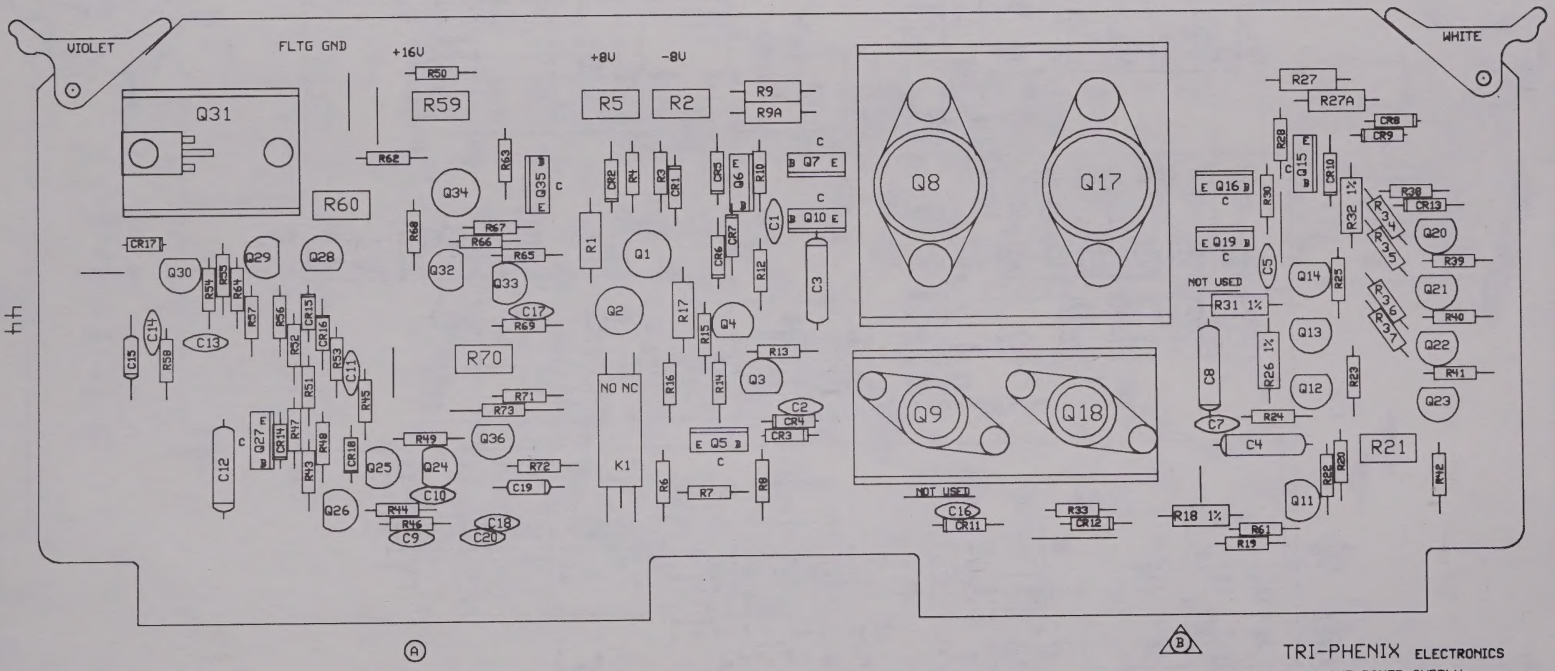
ASSY NO (PX30-01C) 900A3001C1

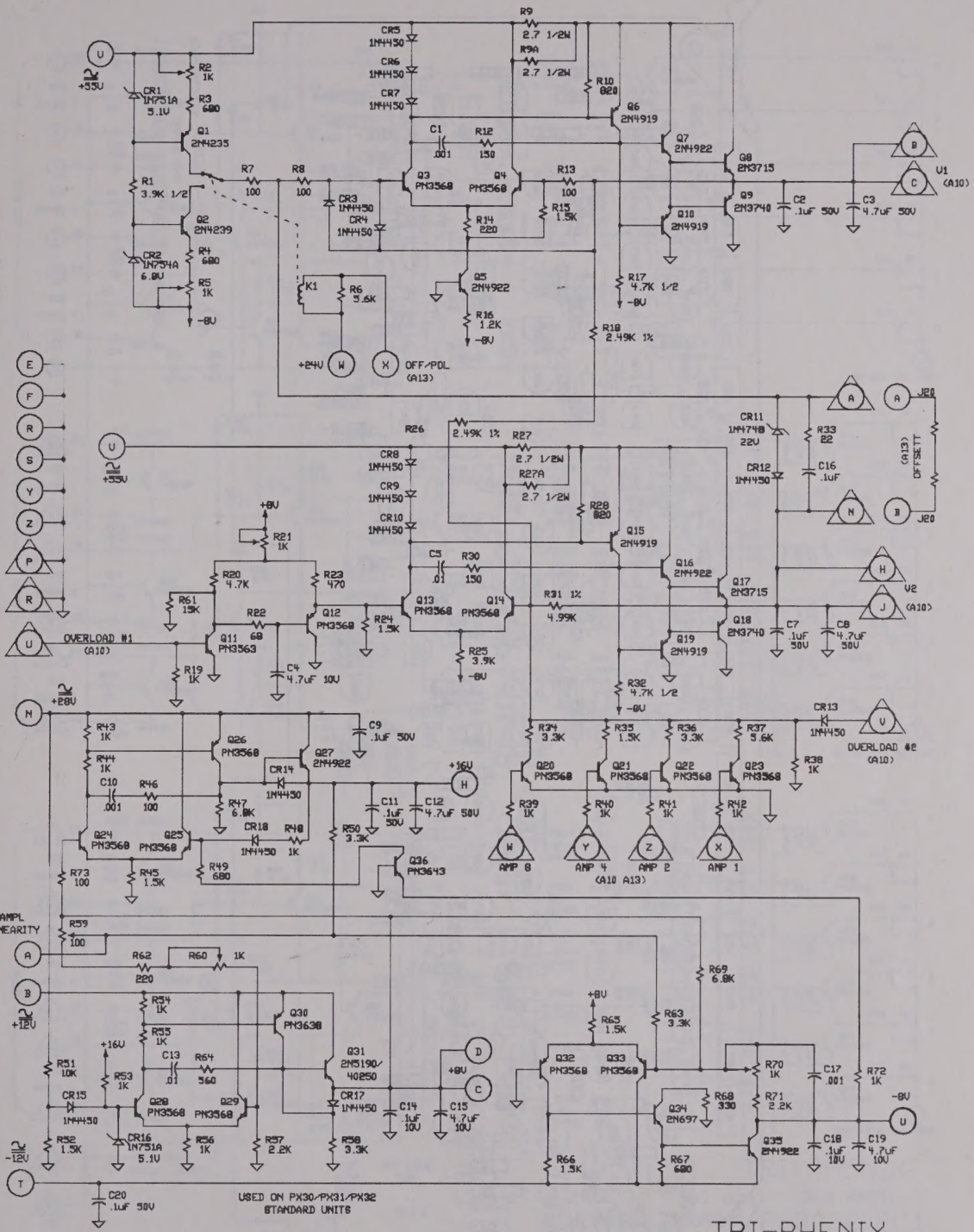


TRI-PHENIX

A7 J15 PULSE FORMER

SCHEMATIC DIAG (PX30-101) 860A3001C1

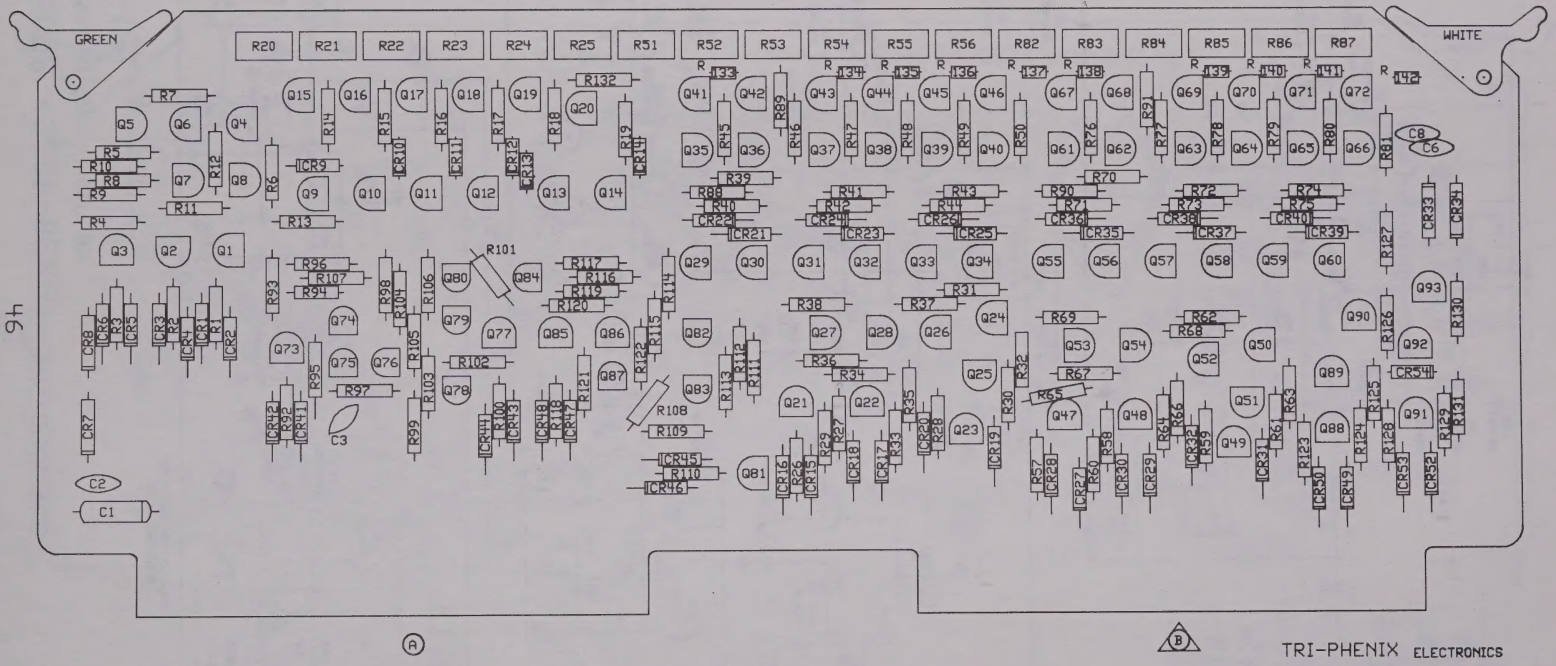

VIOLET
FLTG GND
+16V
+8V
-8V
WHITE
Q31
R59
R5
R2
R9
R9A
R60
R70
Q8
Q17
Q9
Q18
R27
R27A
NOT USED
R31 1%
R21
NO NC
K1
NOT USED
C16
CR11
R33
CR12
R18 1%
TRI-PHENIX ELECTRONICS
OUTPUT POWER SUPPLY
ASSY DWG (PX30-207) 900A3007C1

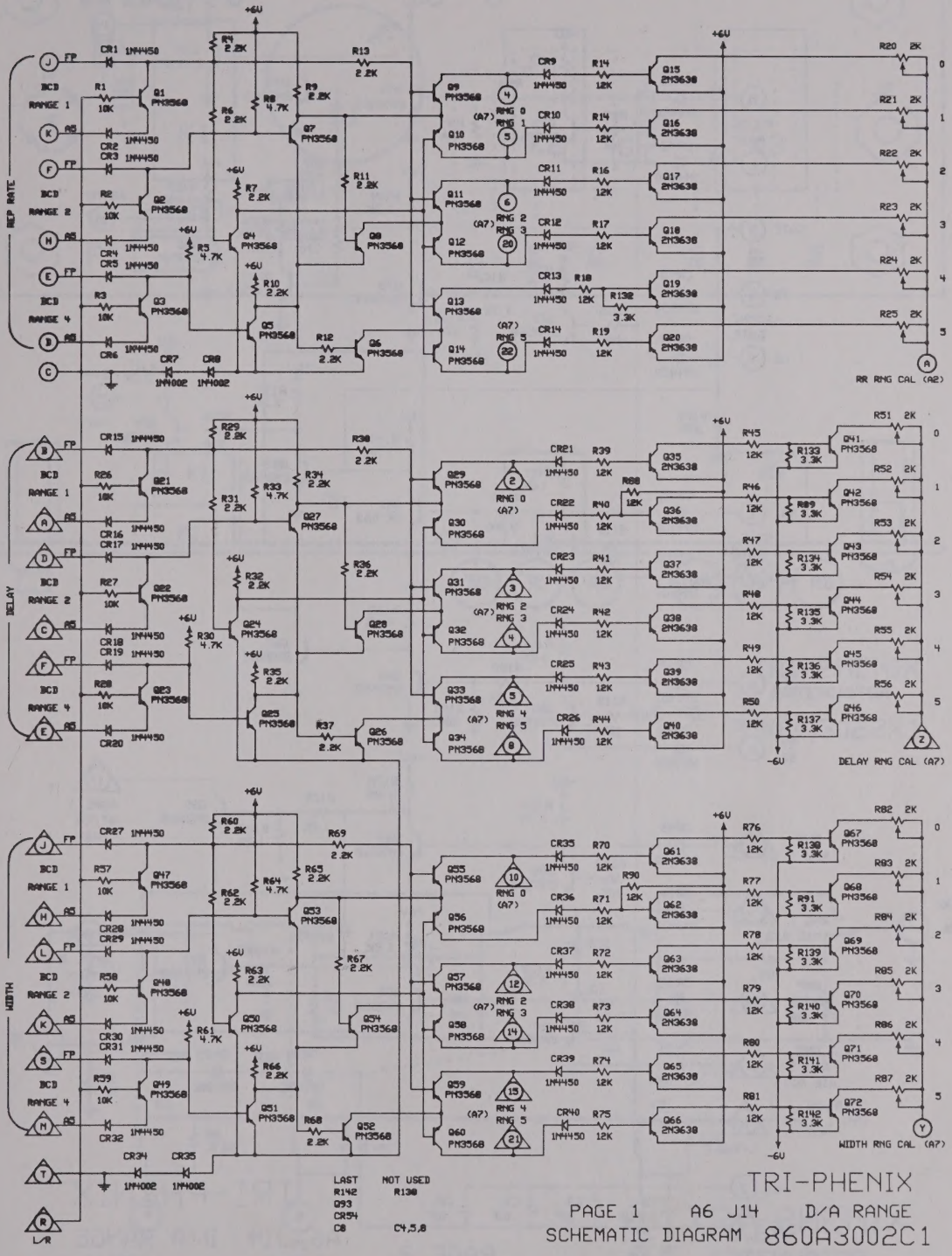


TRI-PHENIX

A8 J16 OUTPUT POWER SUPPLY

SCHEMATIC DIAG (PX30-107C) 860A3007C1


GREEN
WHITE
R20
R21
R22
R23
R24
R25
R51
R52
R53
R54
R55
R56
R82
R83
R84
R85
R86
R87
A
B
TRI-PHENIX ELECTRONICS
D/A RANGE
ASSY DWG (PX30-202) 900A3002C1

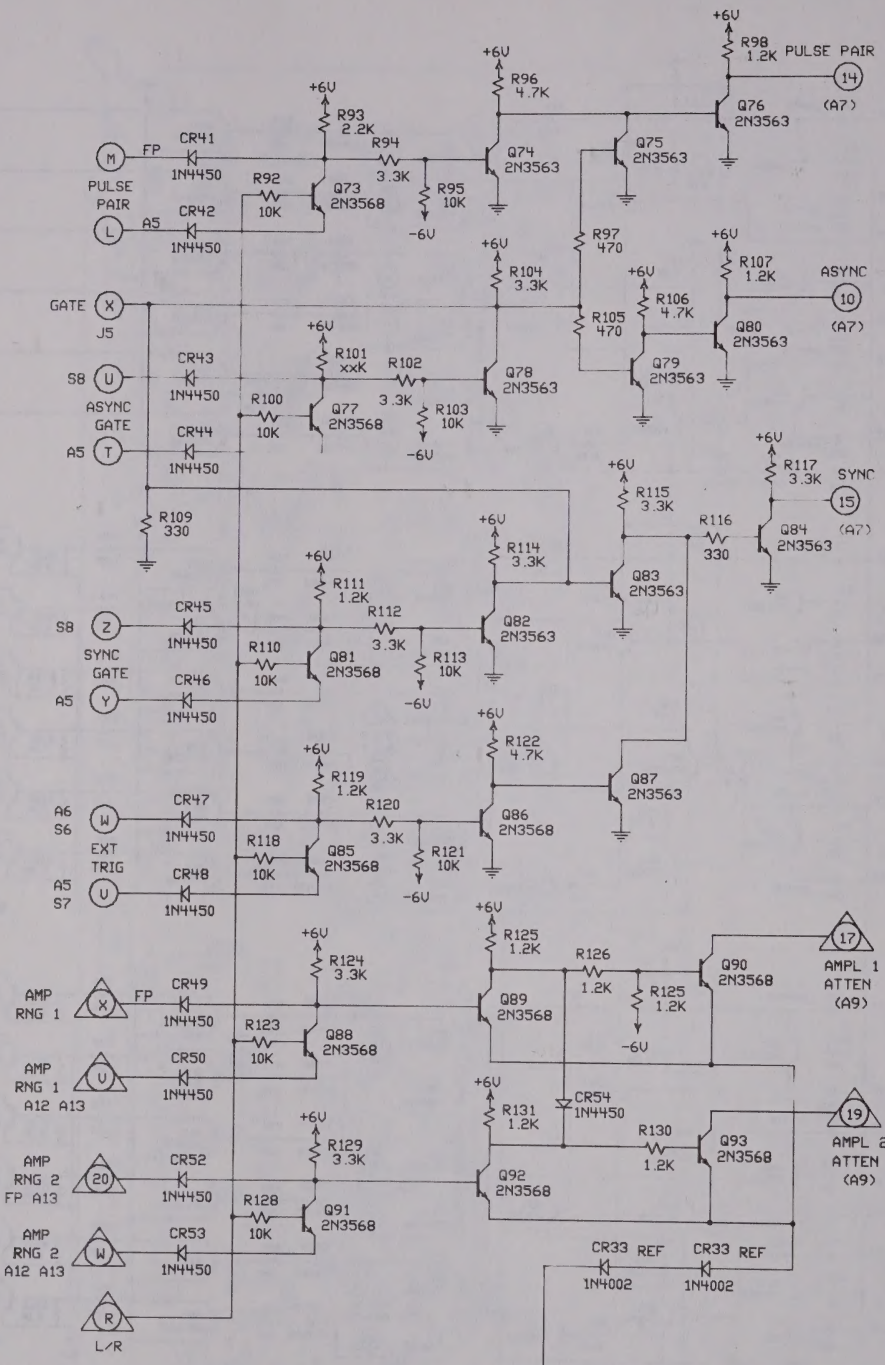


LAST	NOT USED
R142	R138
Q93	
CR54	
C8	C4,5,8

TRI-PHENIX

PAGE 1 A6 J14 D/A RANGE

SCHEMATIC DIAGRAM 860A3002C1

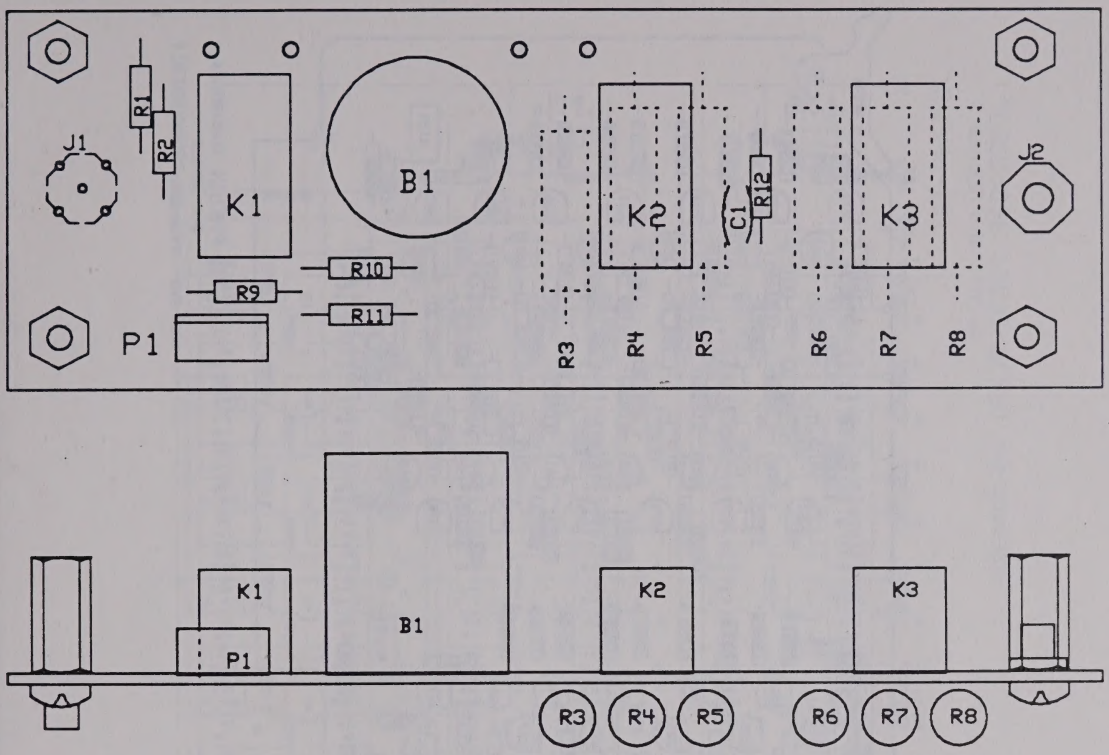


TRI-PHENIX

A6 J14 D/A RANGE

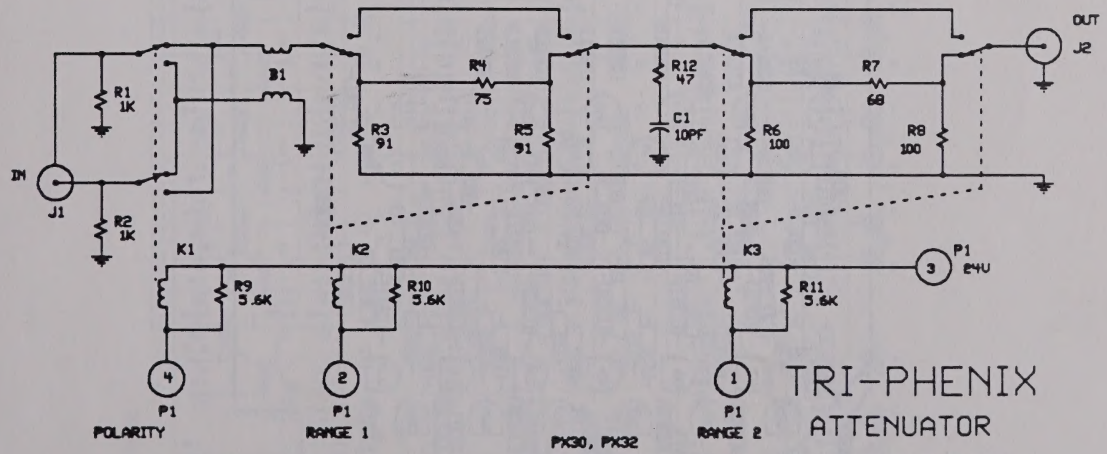
PAGE 2

SCHEMATIC DIAG 860A3002C1



TRI-PHENIX
ATTENUATOR

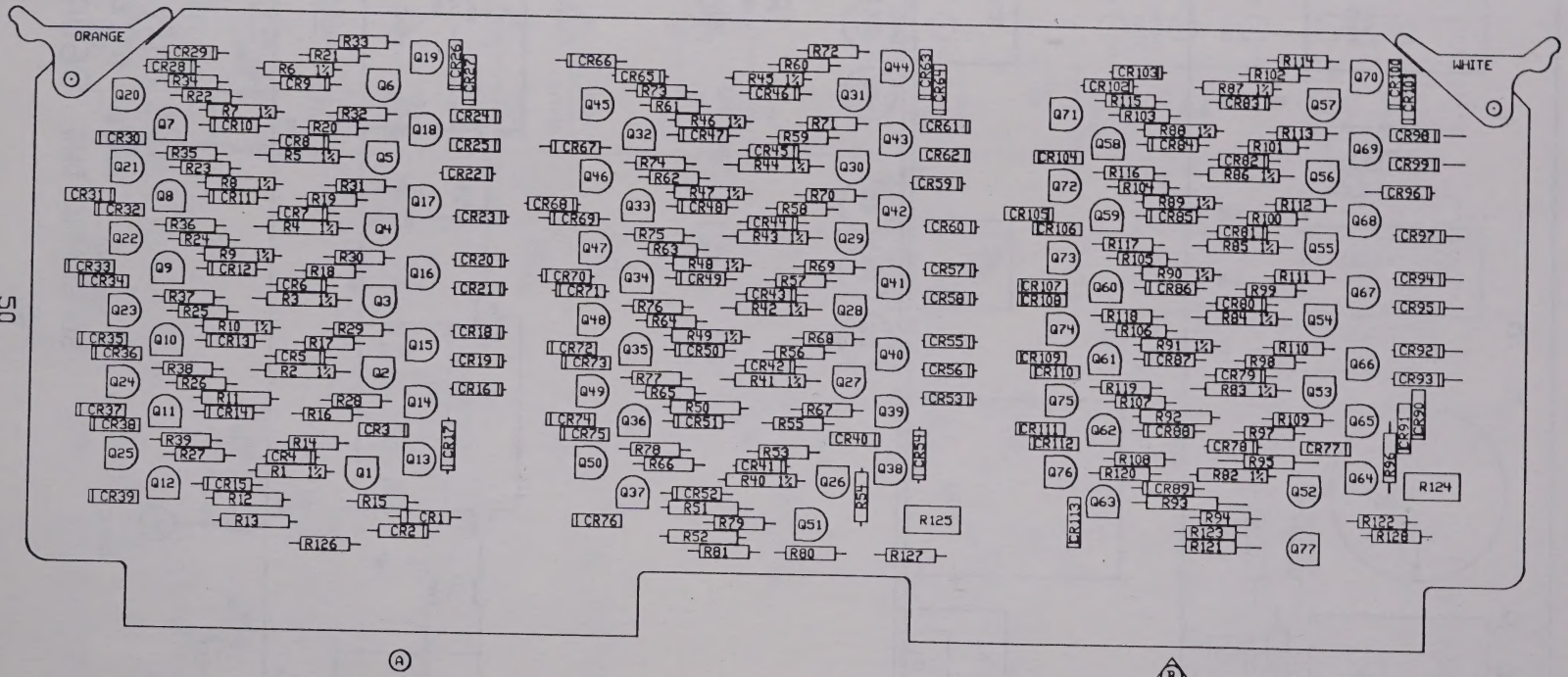
DWG NO 900A3022X1



PX30, PX32

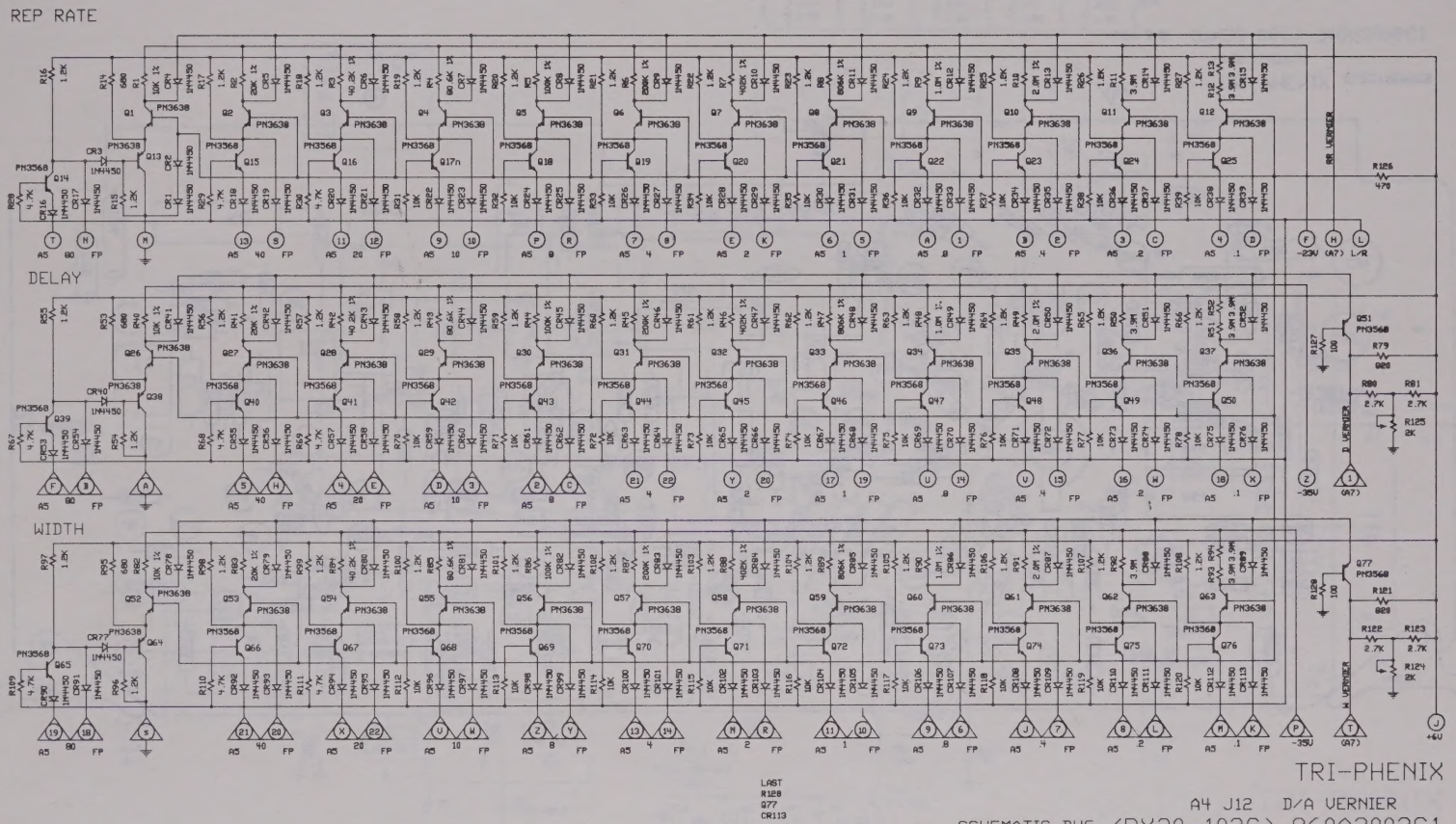
TRI-PHENIX
ATTENUATOR

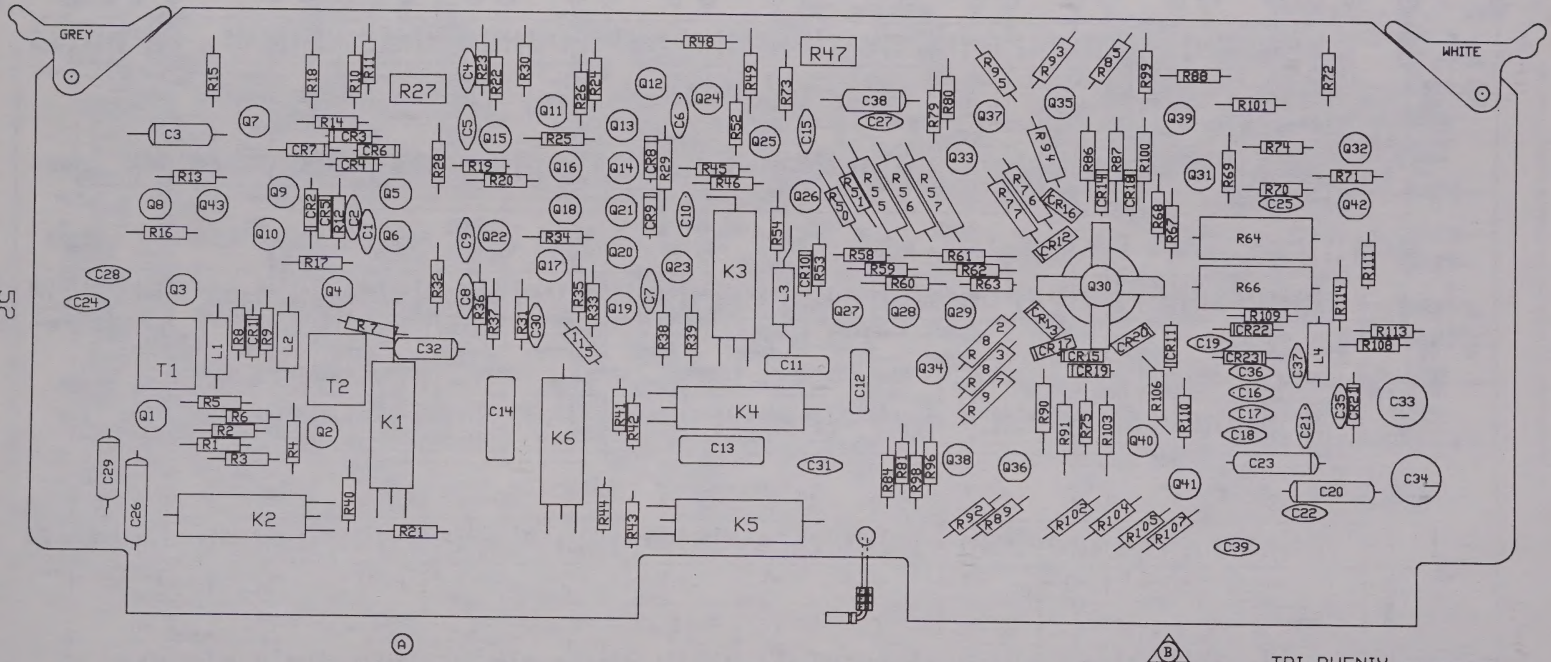
SCHEMATIC DWG 860A3022X1



TRI-PHENIX ELECTRONICS
D/A VERNIER
ASSY DWG (PX30-203) 900A3003C1

50

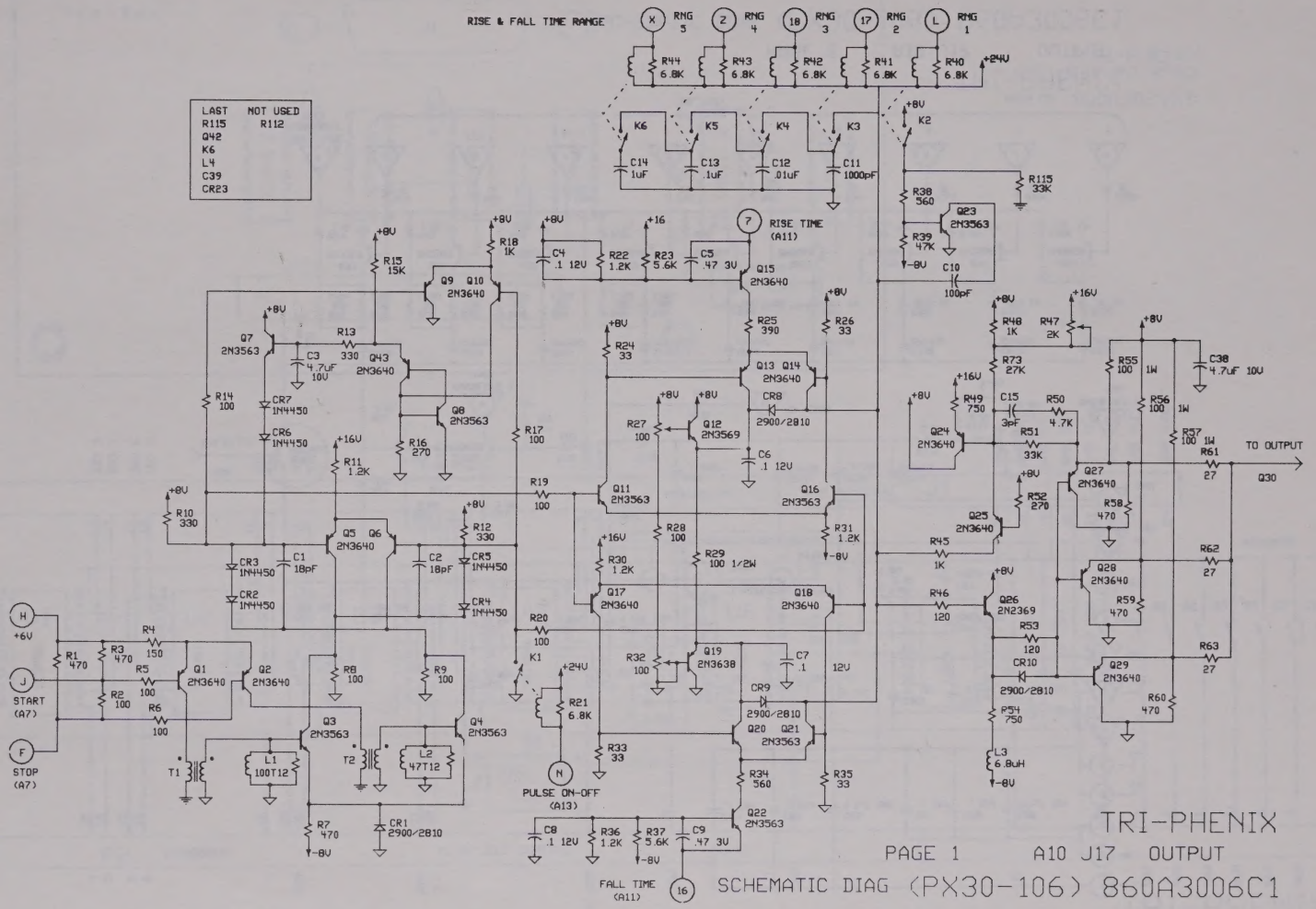

REP RATE
DELAY
WIDTH
R/R VERNIER
D VERNIER
W VERNIER
TRI-PHENIX
A4 J12 D/A VERNIER
SCHEMATIC DWG (PX30-103C) 860A3003C1
LAST
R128
Q77
CR113

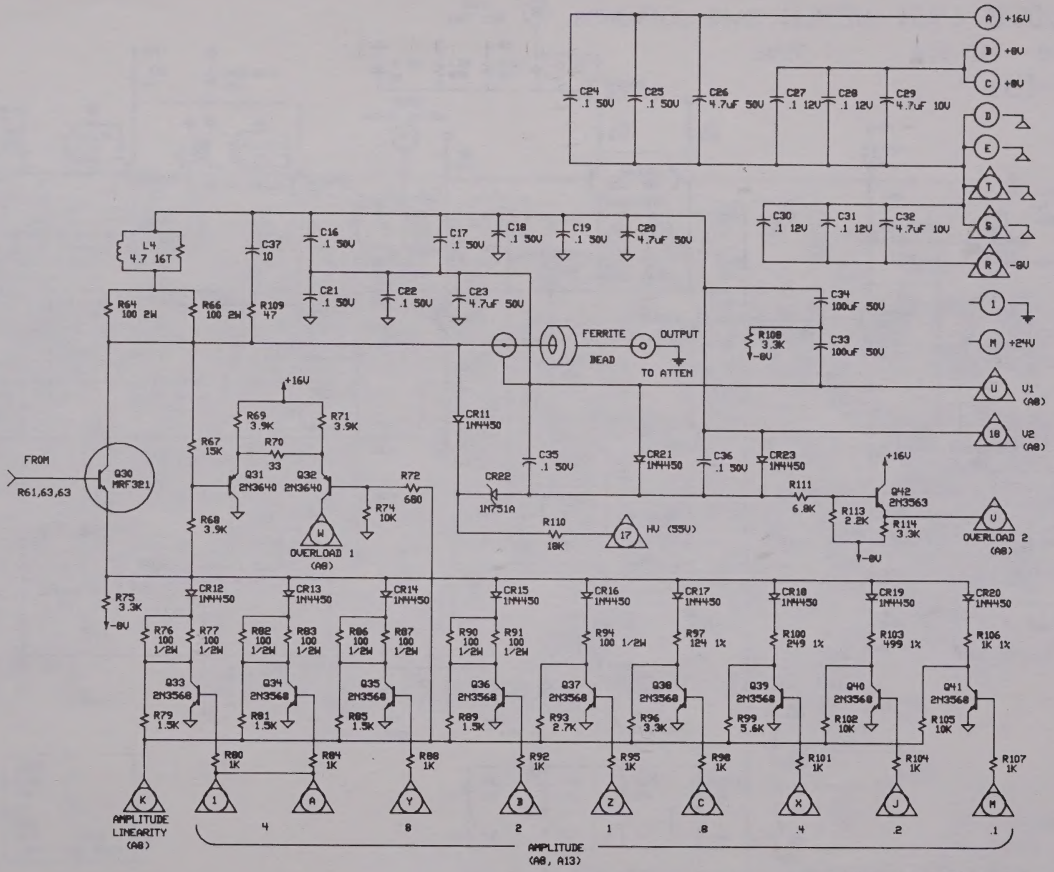


TRI-PHENIX ELECTRONICS

A10 OUTPUT

ASSY DWG (PX30-06C) 900A3006C1

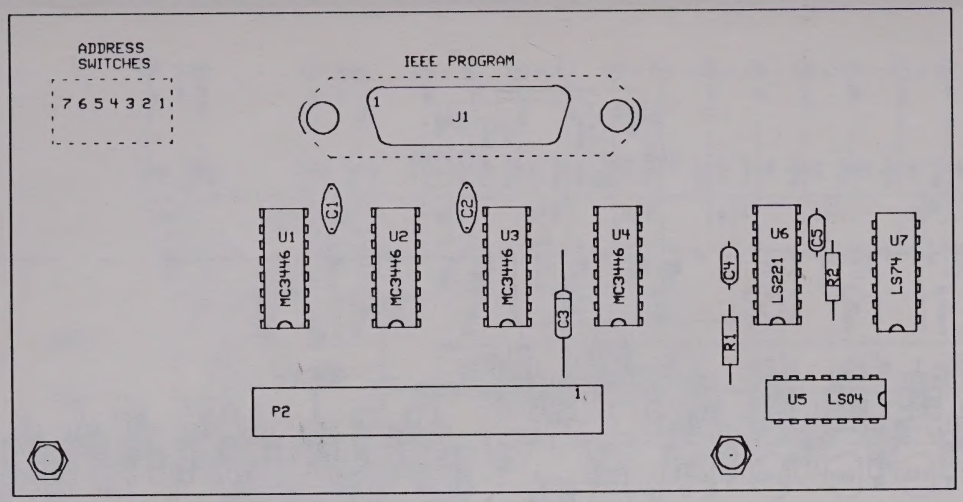

RISE & FALL TIME RANGE
RNG 5
RNG 4
RNG 3
RNG 2
RNG 1
LAST NOT USED
R115 R112
Q42
K6
L4
C39
CR23
RISE TIME (A11)
TO OUTPUT
Q30
START (A7)
STOP (A7)
PULSE ON-OFF (A13)
FALL TIME (A11)
TRI-PHENIX
PAGE 1 A10 J17 OUTPUT
SCHEMATIC DIAG (PX30-106) 860A3006C1



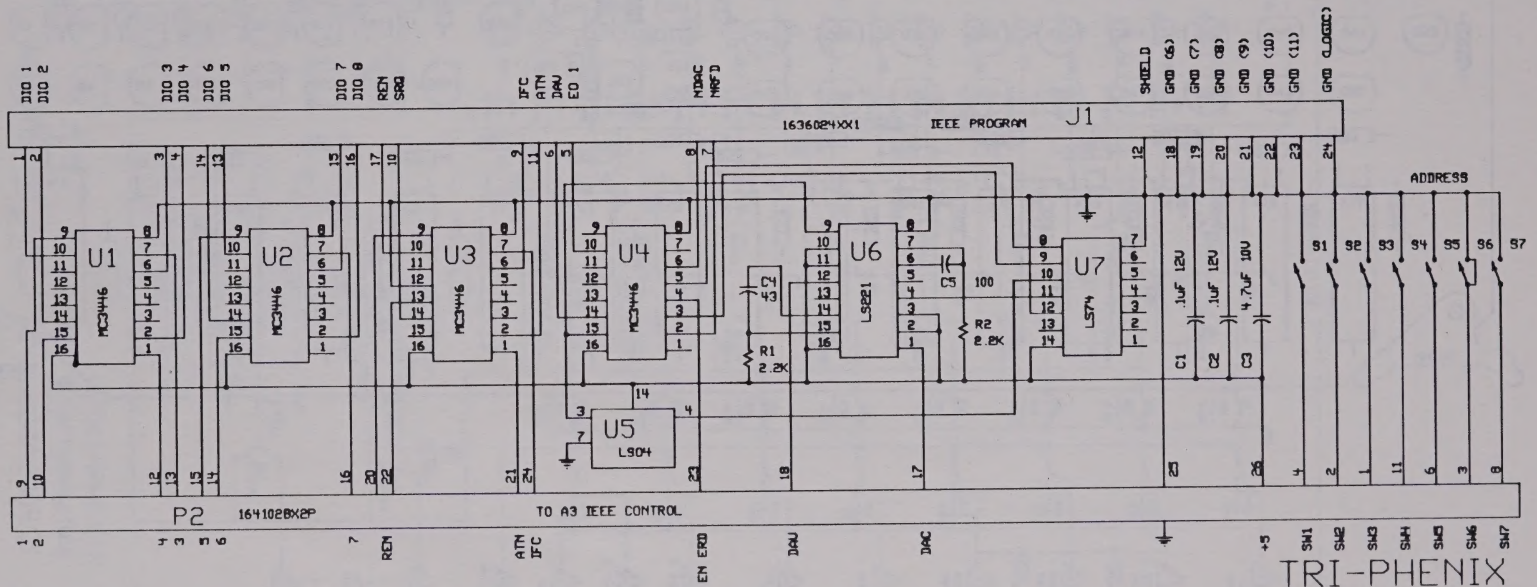
TRI-PHENIX

PAGE 2 A10 J17 OUTPUT

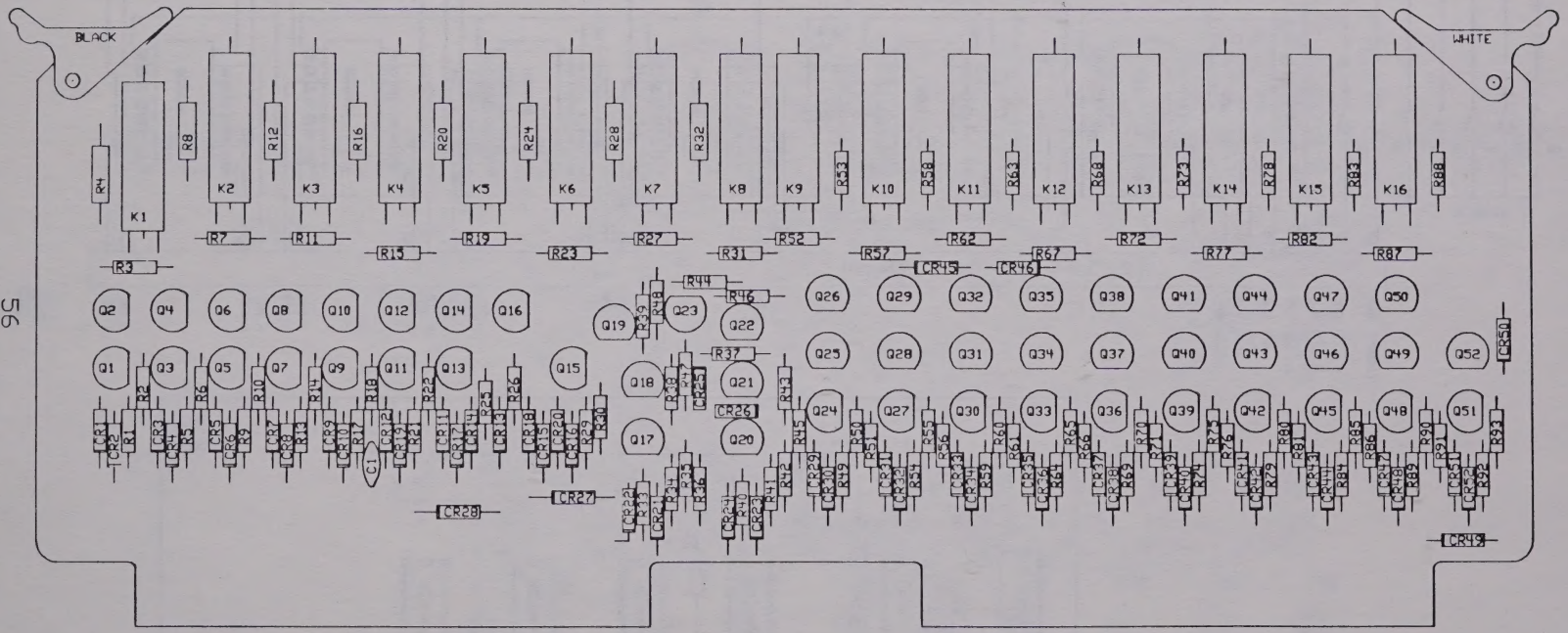
SCHEMATIC DIAG (PX30-106) 860A3006C1



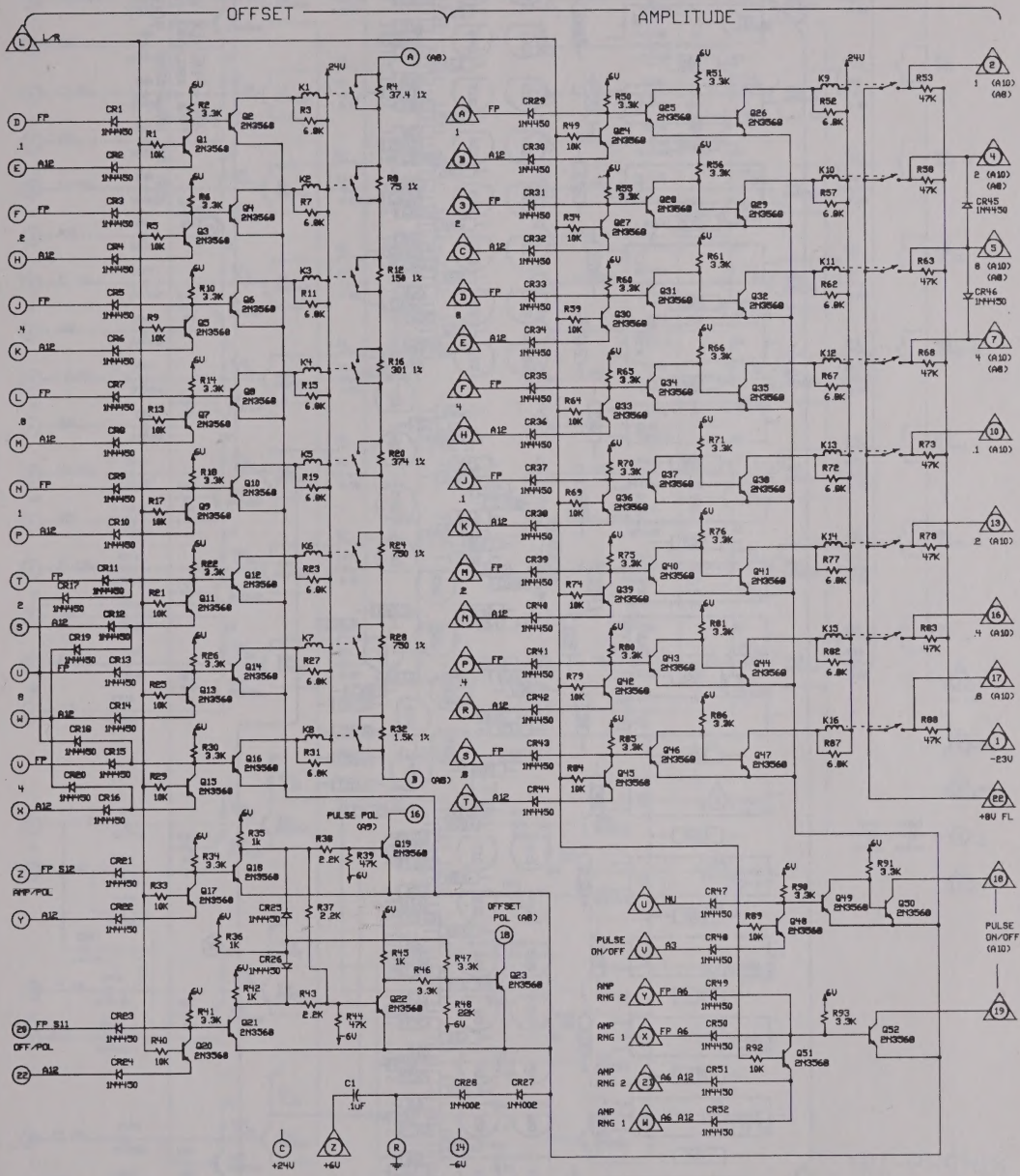
TRI-PHENIX
A15 IEEE INTERFACE
ASSY NO 900A3024X1



TRI-PHENIX
FILE NO PX30124.SCH A15 IEEE INTERFACE
SCHEMATIC DIAG 860A3024X1



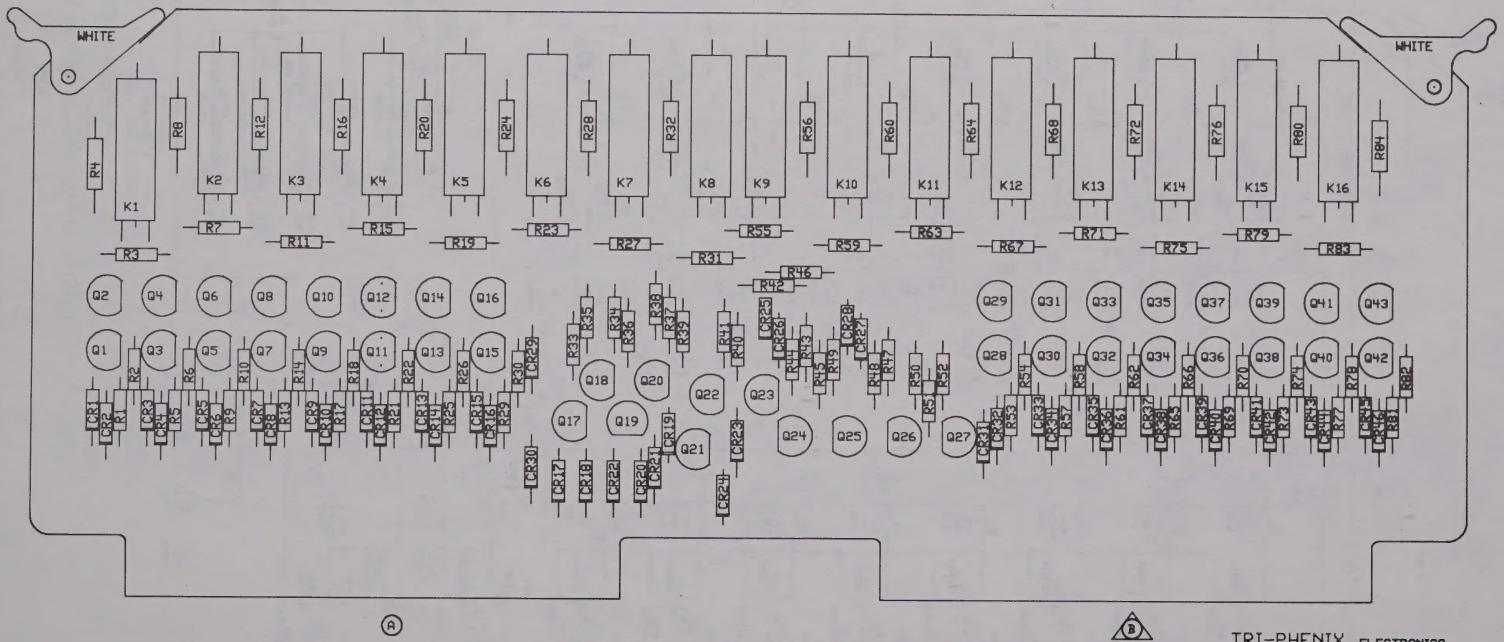
TRI-PHENIX
OFFSET/AMPLITUDE
ASSY DWG (PX30-04C) 900A3004C1



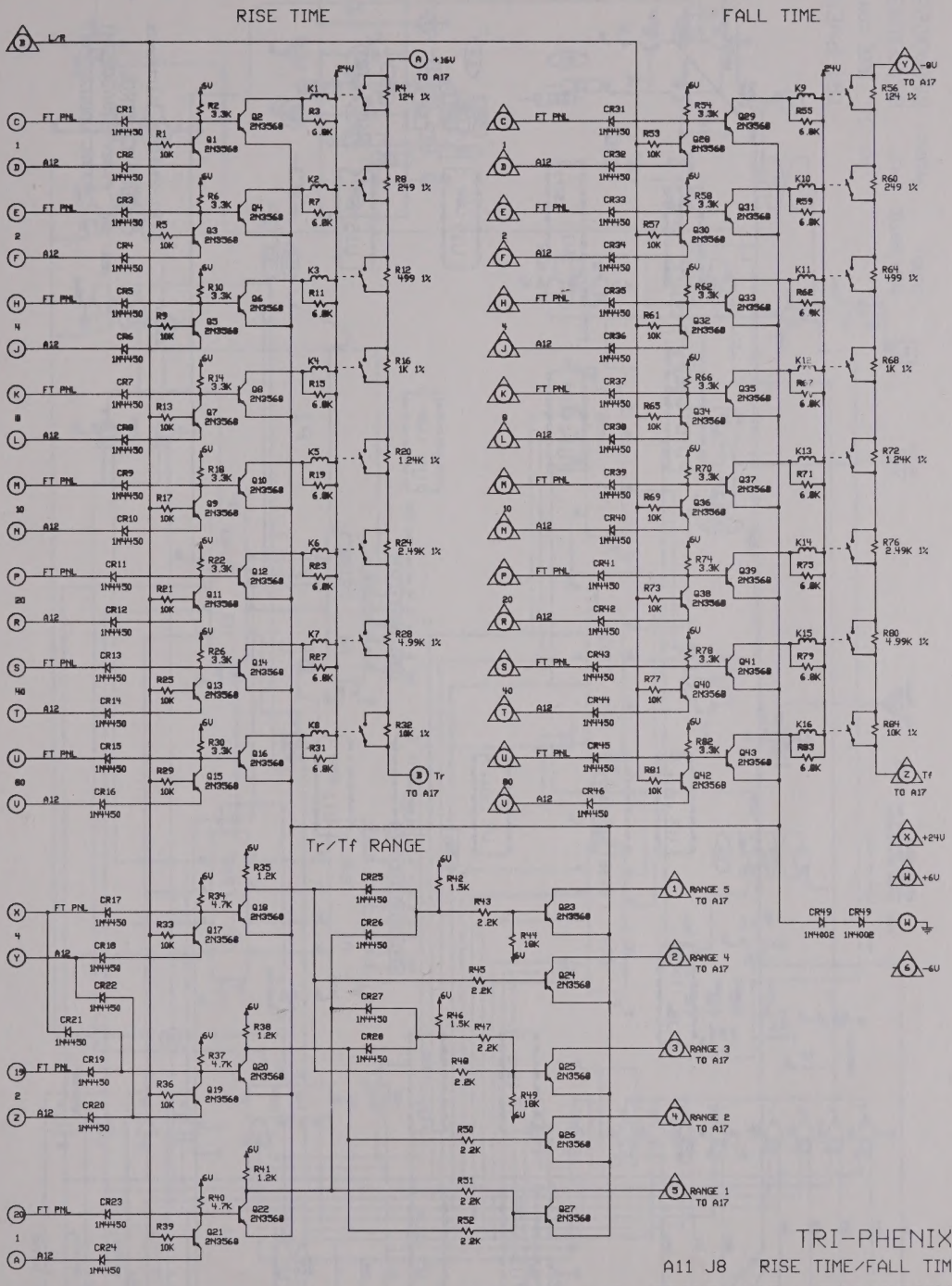
TRI-PHENIX

A13 J20 OFFSET/AMPLITUDE

SCHEMATIC DIAG (PX30-104) 860A3004C1



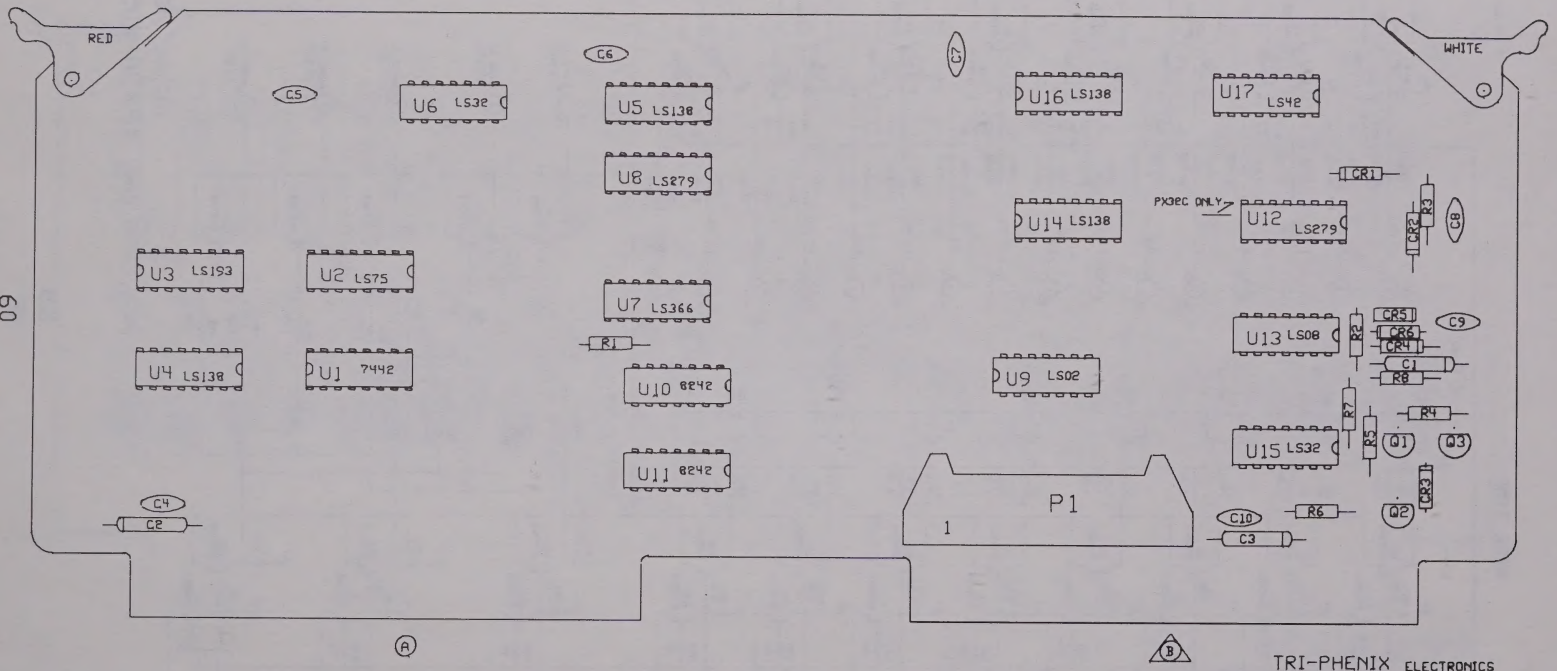
TRI-PHENIX ELECTRONICS
RISE/FALL TIME
ASSY DWG (PX30-205C) 900A3005C1



TRI-PHENIX

A11 J8 RISE TIME/FALL TIME

SCHEMATIC DIAG (PX30-105) 860A3005C1

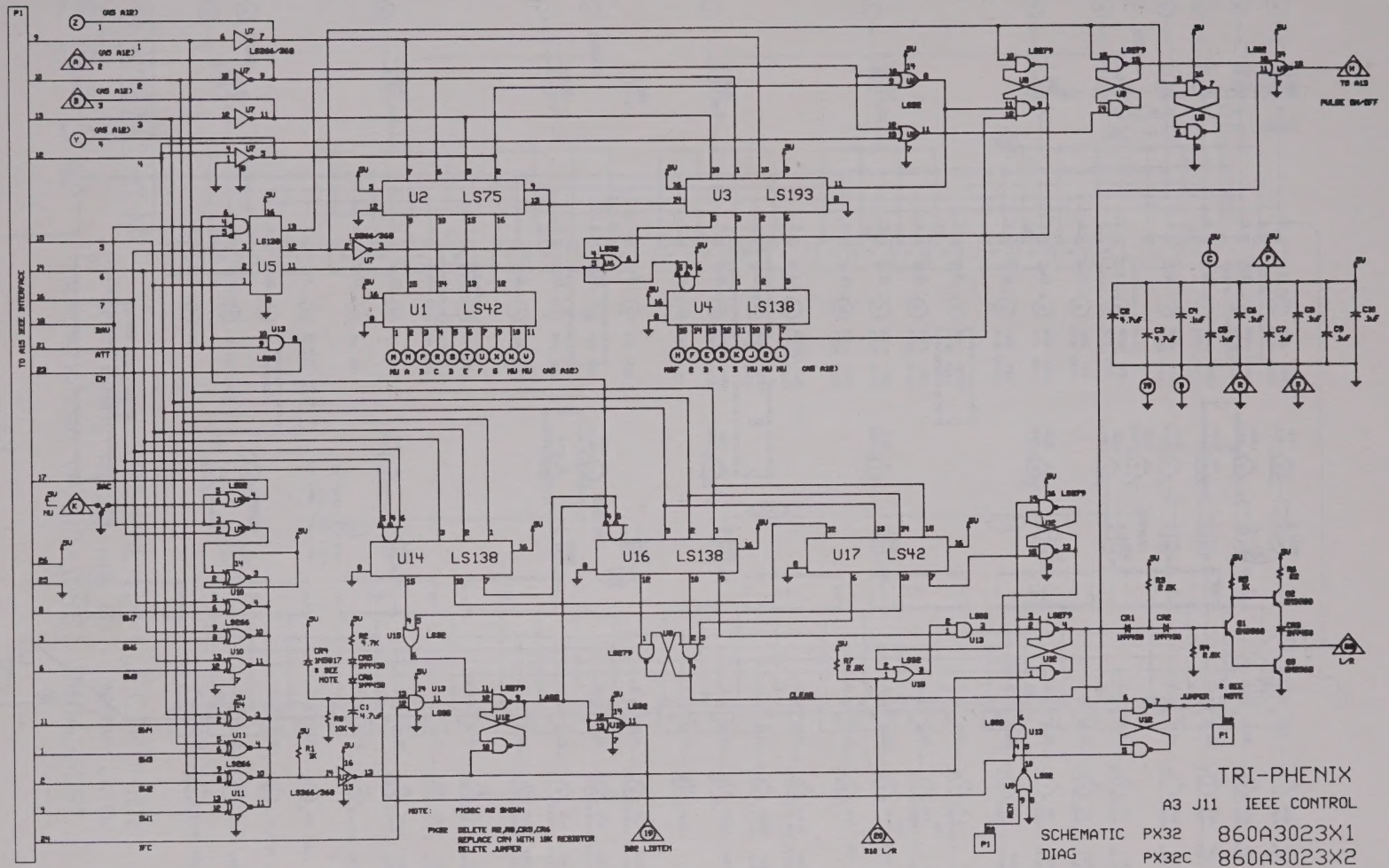


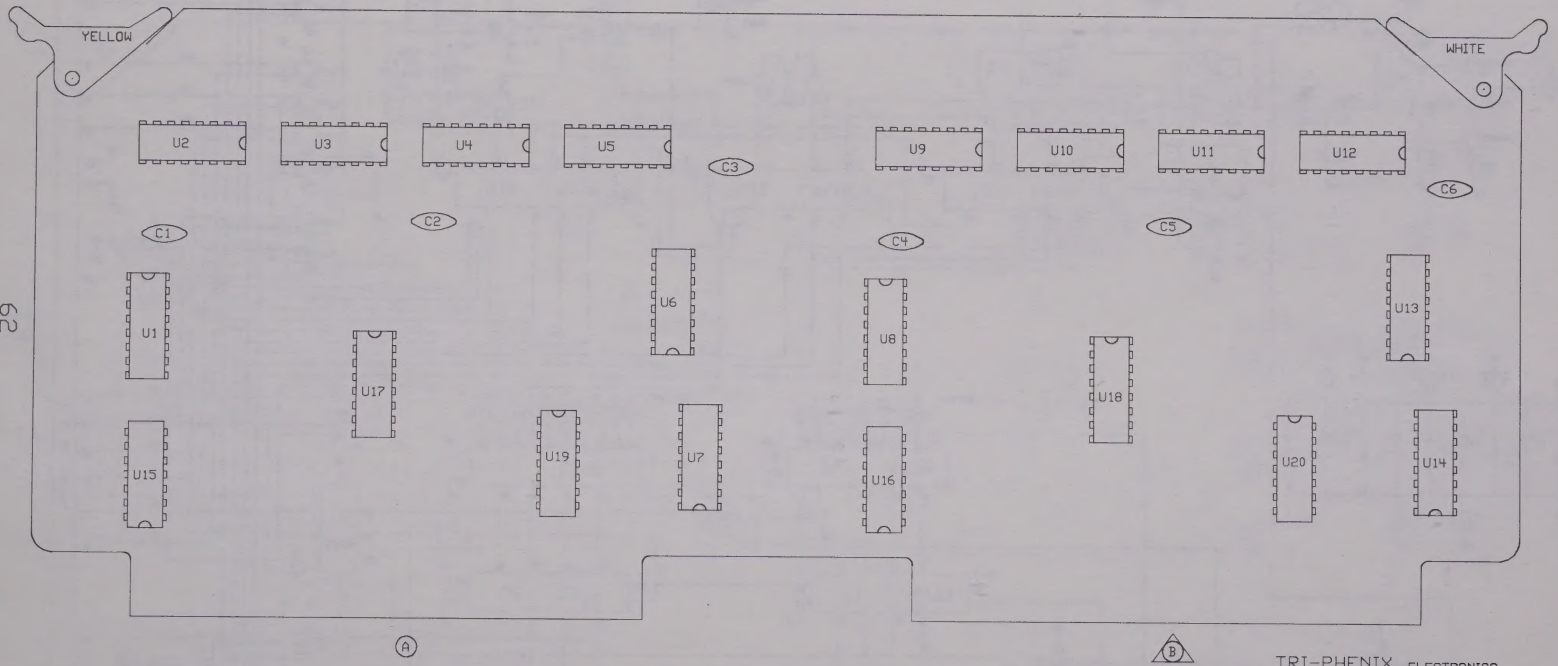
TRI-PHENIX ELECTRONICS

IEEE CONTROL

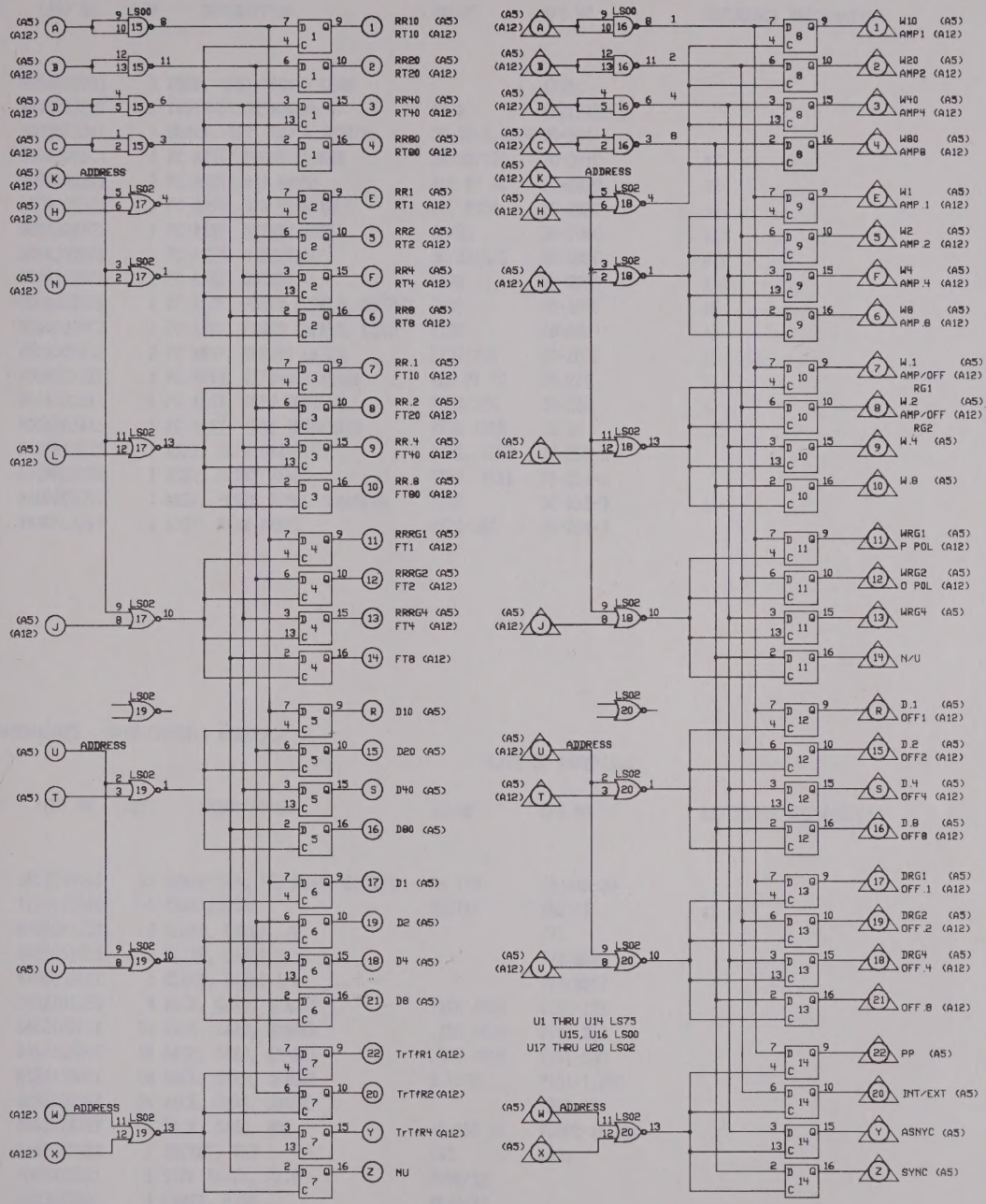
ASSY DWG PX32 900A3023X1

PX32C 900A3023X2


U2 LS75
U3 LS193
U1 LS42
U4 LS138
U5
U14 LS138
U16 LS138
U17 LS42
TRI-PHENIX
A3 J11 IEEE CONTROL
SCHEMATIC PX32 860A3023X1
DIAG PX32C 860A3023X2



TRI-PHENIX ELECTRONICS
MEMORY LATCH
ASSY DWG (PX30-209) 900A3009C1



Vcc PIN 5, GND PIN 12
Vcc PIN 14, GND PIN 7
Vcc PIN 14, GND PIN 7

TRI-PHENIX ELECTRONICS

A5 J13, A12 J19 MEMORY LATCH

SCHEMATIC DIAG (PX30-109C) 860A3009C1

9800PX32C1 PULSE GENERATOR, PX32 IEEE

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	565193000X	1	CORD, ASSY, POWER CORD		17250	
2	6821PX32C1	1	INSTRUCTION MANUAL	PX32	6821PX32C1	
3	70030X3041	1	COVER, SET, TOP & BOTTOM	30,30-2,32,G	30-304-1	
4	900A3001C1	1	PC ASSY, PULSE FORMER	30/32/32G	30-201C	A7
5	900A3002C1	1	PC ASSY, D/A RANGE	ALL PX 30	30-202C	A6
6	900A3003C1	1	PC ASSY, D/A VERNIER	ALL PX30	30-203C	A4
7	900A3004C1	1	PC ASSY, OFFSET/AMPL	30/32	30-204C	A13
8	900A3005C1	1	PC ASSY, RISE/FALL	30/32/32G	30-205C	A11
9	900A3006C1	1	PC ASSY, OUTPUT	PX30	30-206C	A10
10	900A3007C1	1	PC ASSY, POWER SUPPLY, OUTPUT	PX32	30-207C	A8
11	900A3008C3	1	PC ASSY, POWER SUPPLY, LOGIC	PX32	30-08C	A2
12	900A3009C3	2	PC ASSY, MEMORY LATCH	PX32/32G	30-209C	A5, A12
13	900A3013X1	1	PC ASSY, EXTENDER BOARD	ALL PX 30	30-213	A1
14	900A3023X1	1	PC ASSY, IEEE CONTROL	PX32/32G	30-223	A3
15	900A3024X1	1	PC ASSY, IEEE INTERFACE	PX32 IEEE	30-24	A15
16	940CHA30X3	1	ASSY, MAIN CHASSIS	PX32, IEEE	30-255-3	
17	940FPL30X3	1	ASSY, FRONT PANEL	PX32, IEEE	30-251-3	
18	940PSC30X3	1	ASSY, POWER SUPPLY CHASSIS	PX32	30-253-3	A14
19	940RPL30X3	1	ASSY, REAR PANEL	PX32/32G	30-254-3	

940CHA30X3 MAIN CHASSIS ASSEMBLY

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1612044001	23	CONNECTOR, PC, DUAL READOUT	44 PIN	50-44A-30	
2	520371503X	1	TRANSISTOR	2N3715	2N3715	A2 Q5
3	640605125X	2	CLAMP, CABLE 1/8		771	
4	640605188X	2	CLAMP, CABLE 3/16		772/8956	
5	640605250X	1	CLAMP, CABLE 1/4		773/8957	
6	645210125X	8	RACK, CARD, SPACER	.125 INCH	T101-125	
7	645210250X	24	RACK, CARD, SPACER	.250 INCH	T101-250	
8	645210500X	16	RACK, CARD, SPACER	.500 INCH	T101-500	
9	645211000X	28	RACK, CARD, SPACER	1 INCH	T101-1.000	
10	645220939X	24	RACK, CARD, GUIDE		T309-39	
11	645241675X	4	RACK, CARD, ROD	16.750 IN.	TS902-16.750	
12	646400T03X	1	SOCKET, T03	T03	4601	
13	70030X3021	1	SIDE PANEL, PAIR	PX30/32		
14	70030X3041	1	COVER, PAIR	PX30/32		
15	70030X3083	1	MAIN CHASSIS, IEEE	PX32-PX32G	30-308-3	
16	70030X3101	1	BRACKET, CHASSIS BRACE	ALL 30	30-310-1	

940FPL30X3 FRONT PANEL ASSEMBLY

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
	281000001X	1	LAMPHOLDER		508-7438-504	
	282000001X	1	LAMP, NEON		CR01-CCB-N123	
	284000002X	2	LAMP, LED HOLDER		515-0005	
	284000003X	2	LED HOLDER, SOCKET		Q084-3D	
	440207101X	5	SWITCH, TOGGLE, MIN, PANEL MT	SPDT	7101SYZQ	
	440207103X	1	SWITCH, TOGGLE, MIN, PANEL MT	SPDT CEN OFF	7103SYZQ	
	440300370X	2	SWITCH, ROD, THUMBWHEEL		012-0370	
	440300571X	4	SWITCH, SPACER, THUMBWHEEL	1/2 INCH	009-0571	
	440300744X	4	SWITCH, ROD RETAINER		012-0744	
	440301034X	2	SWITCH, ENDCAP, THUMBWHEEL		009-1034	
	440302002A	17	SWITCH, THUMBWHEEL	BCD	T20-02A	
	440302068A	5	SWITCH, THUMBWHEEL	BCD 0-5	T20-68AF	
	440508531X	1	SWITCH, PUSH BUTTON		8531MZQ	
	642810456X	2	HANDLE, 5/16 DIA, NI PLATE	4.56 INCH	B 1013-13	
	642820001X	4	HANDLE, FERRULE, NI PLATE		B 900-13	
	70030X3091	1	BRACKET, SWITCH MTG	ALL	30-309-1	
	70030X3111	2	BRACKET, FRONT PANEL	ALL 30,219	30-311-1	
	70032X4001	1	FRONT PANEL, IEEE	PX32	32-400-1	

940RPL30X3 REAR PANEL ASSEMBLY

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1622001001	4	CONNECTOR, BNC, UG1094/U		31-221	
2	1623001001	1	CONNECTOR, PLUG, MIN		51-007-000	
3	1650003XXX	1	CONNECTOR, AC 3 WIRE		17252/EAC301 OR	
4	221001000X	1	FUSE, 3AG, 1 A SB	1 A SB	313001	
5	223342004X	1	FUSE HOLDER, 3AG		342004	
6	301000002X	1	MOTOR, FAN 4.71 SQ, 105 CFM	MUFFIN	MU2A1	
7	6460001EEE	2	SPACER, STAND OFF, IEEE		408-15277-5 (-6)	
8	70032X3012	1	PANEL, REAR	PX32 IEEE		
9	90PX40203X	1	PC ASSEMBLY, IEEE BD	PX30	900A3024XX	

940PSC30X3 POWER SUPPLY CHASSIS ASSEMBLY

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
	1034108K4X	1	CAPACITOR, ELECTROLYTIC, 75V	1000 UF	CG102U075R3C	
	1642206XXS	2	CONNECTOR, END SOCKET	6 PIN	CE100F24-6	
	1642212XXS	1	CONNECTOR, END, SOCKET	12 PIN	CE100F24-12	
	1642306XXC	2	CONNECTOR, COVER	6 PIN	EC100F-6	
	1642312XXC	1	CONNECTOR, COVER	12 PIN	EC100F-12	
	5010122688	2	TRANSFORMER, POWER		122688	
	640600002X	1	CLAMP, ELECT, 1 3/8-1 7/16	1 3/8-1 7/16	VR3	
	640605125X	2	CLAMP, CABLE 1/8		771	
	646063208X	2	SPACER, 6-32 X 1/2 HEX		2322	
	646063212X	2	SPACER, 6-32 X 3/4 HEX		2323	
	646814140X	1	TERMINAL, BARRIER STR., 4 POS		4-140	
	70032X307X	1	CHASSIS, POWER SUPPLY		32-307	
	900A3021XX	1	PC ASSY, POWER SUPPLY, UNREG		30-21	

900A3021X1 P.S. UNREG A14

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1033107J7X	2	CAPACITOR, ELECTROLYTIC, 63V	100 UF	ECEA1JU101	C5,6
2	1033157M4X	1	CAPACITOR, ELECTROLYTIC, 150V	150 UF	TC495B	C7
3	1033477E6X	1	CAPACITOR, ELECTROLYTIC, 16V	470 UF	ECEA1CV471S	C3
4	1033477H6X	2	CAPACITOR, ELECTROLYTIC, 35V	470 UF	ECEA1VV471S	C9,11
5	1034108H6X	1	CAPACITOR, ELECTROLYTIC, 50V	1000 UF	ECEA1HVU102S	C4
6	1034158E6X	3	CAPACITOR, ELECTROLYTIC, 16V	1500 UF	ECEA	C1,2,10
7	1642106XXP	2	CONNECTOR, HEADER, POST PLUG	6 PIN	MPSS100-6	P1,3
8	1642112XXP	1	CONNECTOR, HEADER, POST PLUG	12 PIN	MPSS100-12	P2
9	18440020XX	12	DIODE, RECTIFIER, 1 A, 200 V		1N4002	CR3-10,15-18
10	184050103X	6	DIODE, RECTIFIER, 3A 100V		MR501	CR1,2,11,12,13,14
11	382250103J	0	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R1,2,3,4,5
12	80030X21X1	1	PC FAB, POWER SUPPLY UNREG	30-21	PX30-21	

900A3013X1 EXTENDER BOARD A1

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1612044001	2	CONNECTOR, PC, DUAL READOUT	44 PIN		
2	645230202X	2	RACK, CARD, EJECTOR			
3	80030X13XX	1	PC FAB, EXTENDER BOARD	ALL PX30		

900A3008C3 LOGIC POWER SUPPLY A2

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1		0	FACTORY SELECT			C13,19
2		0	FACTORY SELECT			R14A,28,40,45
3	1015103P2K	4	CAPACITOR, CER DISK, 500V 10%	.01 UF	5GAS-S10	C1,6,12,18
4	1016104D1K	8	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	C2,4,7,9,11,16,17,20
5	1016104J1J	2	CAPACITOR, CER DISK, 100V 5%	.1 UF	CZ20A104Z	C14,21
6	1071475C2K	3	CAPACITOR, TANTALUM, 10V 10%	4.7 UF	150D475X9010A2	C3,8,10
7	1071475J2K	2	CAPACITOR, TANTALUM, 50V 10%	4.7 UF	150D475X9050B2	C15,22
8	18547370XD	1	DIODE, ZENER, 1 A	7.5 V	1N4737A	CR1
9	186445002X	6	DIODE, GEN PURPOSE		1N4450	CR2-7
10	382220150J	2	RESISTOR, CARBON FILM, 1/4W 5%	15 OHM	R25150J	R27,39
11	382220330J	1	RESISTOR, CARBON FILM, 1/4W 5%	33 OHM	R25330J	R8
12	382220470J	1	RESISTOR, CARBON FILM, 1/4W 5%	47 OHM	R25470J	R6
13	382230101J	1	RESISTOR, CARBON FILM, 1/4W 5%	100 OHM	R25101J	R44
14	382230151J	1	RESISTOR, CARBON FILM, 1/4W 5%	150 OHM	R25151J	R5
15	382230221J	3	RESISTOR, CARBON FILM, 1/4W 5%	220 OHM	R25221J	R23,35,43
16	382230331J	2	RESISTOR, CARBON FILM, 1/4W 5%	330 OHM	R25331J	R26,38
17	382230471J	2	RESISTOR, CARBON FILM, 1/4W 5%	470 OHM	R25471J	R16,17
18	382230681J	1	RESISTOR, CARBON FILM, 1/4W 5%	680 OHM	R25681J	R18
19	382240102J	4	RESISTOR, CARBON FILM, 1/4W 5%	1 K	R25102J	R3,4,11,19
20	382240122J	1	RESISTOR, CARBON FILM, 1/4W 5%	1.2 K	R25122J	R10
21	382240152J	2	RESISTOR, CARBON FILM, 1/4W 5%	1.5 K	R25152J	R21,33
22	382240472J	3	RESISTOR, CARBON FILM, 1/4W 5%	4.7 K	R25472J	R9,22,34
23	382240682J	1	RESISTOR, CARBON FILM, 1/4W 5%	6.8 K	R25682J	R13
24	382250103J	1	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R20
25	382250153J	2	RESISTOR, CARBON FILM, 1/4W 5%	15 K	R25153J	R12,32
26	382250393J	2	RESISTOR, CARBON FILM, 1/4W 5%	39 K	R25393J	R25,37
27	3823101R8J	2	RESISTOR, CARBON FILM, 1/2W 5%	1.8 OHM	R501R8J	R7,7A
28	382330331J	1	RESISTOR, CARBON FILM, 1/2W 5%	330 OHM	R50331J	R15
29	382340102J	1	RESISTOR, CARBON FILM, 1/2W 5%	1 K	R50102J	R31
30	382340392J	2	RESISTOR, CARBON FILM, 1/2W 5%	3.9 K	R50392J	R24,36
31	383133010F	1	RESISTOR, FIXED FILM, 1/8W 1%	301 OHM	RN60D3010F	R1
32	383141001F	1	RESISTOR, FIXED FILM, 1/8W 1%	1 K	RN60D1001F	R2
33	383142001F	2	RESISTOR, FIXED FILM, 1/8W 1%	2.00 K	RN60D2001F	R30,42
34	386640502J	2	RESISTOR, WW 3W 5%	5 K	3SX502J	R29,41
35	387342021K	1	RESISTOR, VAR, PC MT, 1/2W 10%	2 K	467S202A	R14
36	5203568PXX	4	TRANSISTOR	PN3568-5	PN3568-5	Q1,2,6,7
37	5203638PXX	8	TRANSISTOR	PN3638-5	PN3638-5	Q3,8,10,11,13,14,17,18
38	5203645PXX	2	TRANSISTOR	PN3645-5	PN3645-5	Q15,19
39	520371503X	1	TRANSISTOR	2N3715	2N3715	Q5 (MOUNTED ON CHASSIS)
40	520491903X	1	TRANSISTOR	2N4919	2N4919	Q4
41	520492203X	2	TRANSISTOR	2N4922	2N4922	Q16,20
42	524025004X	2	TRANSISTOR	40250/2N5190	40250/2N5190	Q9,12
43	645230202X	2	RACK, CARD, EJECTOR		S202	E1,2
44	700HSX3001	2	HEAT SINK, SINGLE TO66		HS-309-1	
45	80030X08AX	1	PC FAB, POWER SUPPLY, LOGIC	ALL PX30	30-08A	

900A3001C1 PULSE FORMER A7

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	10113R3Q1K	1	CAPACITOR, CER DISK, 1000V 5%	3.3 PF	DD3R3	C29
2	1012330Q1J	1	CAPACITOR, CER DISK, 1000V 5%	33 PF	DD330	C28
3	1015103P2K	1	CAPACITOR, CER DISK, 500V 10%	.01 UF	5GAS-S10	C11
4	1016104D1K	13	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	C3,12,13,20,21,30-38
5	1022430P3J	3	CAPACITOR, DM, 500V 5%	43 PF	DM10-430J	C10,14,22
6	1023151P3J	1	CAPACITOR, DM, 500V 5%	150 PF	DM15-151J	C1
7	1023431P3J	3	CAPACITOR, DM, 500V 5%	430 PF	DM15-431J	C9,15,13
8	1024472P3J	3	CAPACITOR, DM, 500V 5%	4700 PF	DM19-472J	C8,16,24
9	1055473L4K	3	CAPACITOR, MYLAR, 100V 10%	.047 UF	225P47391WD3/PVC11	C7,17,25
10	1056474L4K	3	CAPACITOR, MYLAR, 100V 10%	.47 UF	225P47491XD3/PVC10	C6,18,26
11	1071475C2K	3	CAPACITOR, TANTALUM, 10V 10%	4.7 UF	150D475X9010A2	C5,19,27
12	1072336C2K	1	CAPACITOR, TANTALUM, 10V 10%	33 UF	150D336X9010B2	C2
13	140100105X	1	CHOKE, FIXED	1 UH	L10G	L5
14	140100475X	3	CHOKE, FIXED	4.7 UF	L47G	L2,3,4
15	140101565X	1	CHOKE, FIXED	15 UF	W150	L1
16	1810TD901X	2	DIODE, TUNNEL		TD9	CR11,14
17	18137180lX	1	DIODE, TUNNEL		1N3718	CR2
18	18440020XX	2	DIODE, RECTIFIER, 1 A, 200 V		1N4002	CR5,6
19	186445002X	10	DIODE, GEN PURPOSE		1N4450	CR1,CR1A,3,4,7,8,9,10,12,13,15
20	362010024X	16	RELAY, REED, SPST	SPST	101-100-24	K1-16
21	382220100J	2	RESISTOR, CARBON FILM, 1/4W 5%	10 OHM	R25100J	R46,66
22	382220270J	4	RESISTOR, CARBON FILM, 1/4W 5%	27 OHM	R25270J	R52,72,79,81
23	382220470J	3	RESISTOR, CARBON FILM, 1/4W 5%	47 OHM	R25470J	R25,51,71
24	382220910J	2	RESISTOR, CARBON FILM, 1/4W 5%	91 OHM	R25910J	R44,65
25	382230101J	11	RESISTOR, CARBON FILM, 1/4W 5%	100 OHM	R25101J	R5,6,9,10,12,23,30,41,49,62,69
26	382230121J	5	RESISTOR, CARBON FILM, 1/4W 5%	120 OHM	R25121J	R20,27,38,39,60
27	382230221J	4	RESISTOR, CARBON FILM, 1/4W 5%	220 OHM	R25221J	R7,11,47,68
28	382230271J	2	RESISTOR, CARBON FILM, 1/4W 5%	270 OHM	R25271J	R40,61
29	382230331J	7	RESISTOR, CARBON FILM, 1/4W 5%	330 OHM	R25331J	R1,4,21,28,31,45,80
30	382230471J	4	RESISTOR, CARBON FILM, 1/4W 5%	470 OHM	R25471J	R24,26,43,64
31	382240102J	5	RESISTOR, CARBON FILM, 1/4W 5%	1 K	R25102J	R3,8,14,48,67
32	382240122J	2	RESISTOR, CARBON FILM, 1/4W 5%	1.2 K	R25122J	R42,63
33	382240222J	1	RESISTOR, CARBON FILM, 1/4W 5%	2.2 K	R25222J	R13
34	382240332J	11	RESISTOR, CARBON FILM, 1/4W 5%	3.3 K	R25332J	R17,50,59,70,78,82,83,85,86,88,89
35	382240472J	2	RESISTOR, CARBON FILM, 1/4W 5%	4.7 K	R25472J	R15,18
36	382240682J	16	RESISTOR, CARBON FILM, 1/4W 5%	6.8 K	R25682J	R16,32-35,37,53,55-58,73-77
37	382250103J	4	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R19,84,87,90
38	382250473J	3	RESISTOR, CARBON FILM, 1/4W 5%	47 K	R25473J	R2,22,29
39	520096706X	2	TRANSISTOR	2N967/964	2N967/964	Q22,31
40	5203563P2X	21	TRANSISTOR	PN3563-18	PN3563-18	Q1,3,4,7-9,11,12,18-21,23,24, Q28,29,30,32,33,35,37
41	52035680XX	6	TRANSISTOR	2N3568	2N3568	Q13,14,15,16,26
42	5203640P2X	5	TRANSISTOR	PN3640-18	PN3640-18	Q5,6,10,25,34
43	52039060XX	3	TRANSISTOR	PX3906	PN3906	Q2,17,27
44	645230202X	2	RACK, CARD, EJECTOR		S202	
45	6468236502	26	TERMINAL, STAKED		3650-8 SILVER	
46	80030X01C1	1	PC FAB, PULSE FORMER	ALL PX30	PX30-01C	

900A3003C1 D/A VERNIER A4

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	18440020XX	2	DIODE, RECTIFIER, 1 A, 200 V		1N4002	CR1,2
2	186445002X	110	DIODE, GEN PURPOSE		1N4450	CR3-113
3	382230101J	2	RESISTOR, CARBON FILM, 1/4W 5%	100 OHM	R25101J	R127,128
4	382230471J	1	RESISTOR, CARBON FILM, 1/4W 5%	470 OHM	R25471J	R126
5	382230681J	3	RESISTOR, CARBON FILM, 1/4W 5%	680 OHM	R25681J	R14,53,95
6	382230821J	2	RESISTOR, CARBON FILM, 1/4W 5%	820 OHM	R25821J	R79,121
7	382240122J	39	RESISTOR, CARBON FILM, 1/4W 5%	1.2 K	R25122J	R15-27,54-66,96-108
8	382240272J	4	RESISTOR, CARBON FILM, 1/4W 5%	2.7 K	R25272J	R80,81,122,123
9	382240472J	9	RESISTOR, CARBON FILM, 1/4W 5%	4.7 K	R25472J	R28,29,30,67,68,69,109,110,111
10	382250103J	27	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R31-39,70-78,112-120
11	382270205J	3	RESISTOR, CARBON FILM, 1/4W 5%	2 MEG	R25205J	R10,49,91
12	382270395J	9	RESISTOR, CARBON FILM, 1/4W 5%	3.9 MEG	R25395J	R11,12,13,50,51,52,92,93,94
13	383151002F	3	RESISTOR, FIXED FILM, 1/8W 1%	10.00 K	RN60D1002F	R1,40,82
14	383152002F	3	RESISTOR, FIXED FILM, 1/8W 1%	20 K	RN60D2002F	R2,41,83
15	383154022F	3	RESISTOR, FIXED FILM, 1/8W 1%	40.2 K	RN60D4022F	R3,42,84
16	383158062F	3	ESISTOR, FIXED FILM, 1/8W 1%	80.6 K	RN60D8062F	R4,43,85
17	383161003F	3	RESISTOR, FIXED FILM, 1/8W 1%	100 K	RN60D1003F	R5,44,86
18	383162003F	3	RESISTOR, FIXED FILM, 1/8W 1%	200 K	RN60D2003F	R6,45,87
19	383164023F	3	RESISTOR, FIXED FILM, 1/8W 1%	402 K	RN60D4023F	R7,46,88
20	383168063F	3	RESISTOR, FIXED FILM, 1/8W 1%	806 K	RN60D8063F	R8,47,89
21	383171004F	3	RESISTOR, FIXED FILM, 1/8W 1%	1 MEG	RN60D1004F	R9,48,90
22	387342021K	2	RESISTOR, VAR, PC MT, 1/2W 10%	2 K	467S202A	R124,125
23	5203568PXX	38	TRANSISTOR	PN3568-5	PN3568-5	Q14-25,39-51,65-77
24	5203638PXX	39	TRANSISTOR	PN3638-5	PN3638-5	Q1-13,26-38,52-64
25	645230202X	2	RACK, CARD, EJECTOR		S202	
26	80030X03C1	1	PC FAB, D/A VERNIER	ALL PI 30	PI30-03C	

900A3022X1 ATTENUATOR A9

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1012100Q1J	1	CAPACITOR, CER DISK, 1000V 5%	10 PF	DD100	C1
2	1624001001	2	CONNECTOR, JACK, MIN		51-051-000-220	IN,OUT
3	1642104XXP	1	CONNECTOR, HEADER, POST PLUG	4 PIN	MPSS100-4	P1
4	361003007X	3	RELAY, 1/2 CRYSTAL CAN, DPDT	DPDT 1K OHMS	3SAV1890A2	K1,2,3
5	382220470J	1	RESISTOR, CARBON FILM, 1/4W 5%	47 OHM	R25470J	R12
6	382240102J	2	RESISTOR, CARBON FILM, 1/4W 5%	1 K	R25102J	R1,2
7	382240562J	3	RESISTOR, CARBON FILM, 1/4W 5%	5.6 K	R25562J	R9,10,11
8	3845206806	1	RESISTOR, METAL FILM, 2W 2%	68 OHM	RL42S680G	R7
9	3845207506	1	RESISTOR, METAL FILM, 2W 2%	75 OHM	RL42S750G	R4
10	3845209106	2	RESISTOR, METAL FILM, 2W 2%	91 OHM	RL42S910G	R3,5
11	3845301016	2	RESISTOR, METAL FILM, 2W 2%	100 OHM	RL42S101G	R6,8
12	480010806X	1	TOROID, FERRITE CORE, BALUN	CF108-06	OJ41306TC	B1
13	645000002X	1	POTTING CUP, BALUN		2-220-100	B1
14	90030X12X1	1	PC FAB, ATTENUATOR	30-22	PI30-22	

900A3002C1 D/A RANGE A6

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1016104D1K	4	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	C2,3,6,8
2	1071475C2K	1	CAPACITOR, TANTALUM, 10V 10%	4.7 UF	150D475X9010A2	C1
3	18440020XX	4	DIODE, RECTIFIER, 1 A, 200 V	1N4002	1N4002	CR7,8,33,34
4	186445002X	49	DIODE, GEN PURPOSE	1N4450	1N4450	CR1-6,9-32,35-50,52-54
5	382140332J	10	RESISTOR, CARBON FILM, 1/8W 5%	3.3 K	ROHM	R133-142
6	382230331J	2	RESISTOR, CARBON FILM, 1/4W 5%	330 OHM	R25331J	R109,116
7	382230471J	2	RESISTOR, CARBON FILM, 1/4W 5%	470 OHM	R25471J	R97,105
8	382230681J	2	RESISTOR, CARBON FILM, 1/4W 5%	680 OHM	R25681J	R99,108
9	382240122J	9	RESISTOR, CARBON FILM, 1/4W 5%	1.2 K	R25122J	R98,107,111,117,119,125,126, 130,131,65-69,93,101
10	382240222J	26	RESISTOR, CARBON FILM, 1/4W 5%	2.2 K	R25222J	R4,6,7,9-13,29,31,32,34-38, 60,62,63
11	382240332J	14	RESISTOR, CARBON FILM, 1/4W 5%	3.3 K	R25332J	R88-91,94,102,104,112,114, R115,120,124,129,132
12	382240472J	9	RESISTOR, CARBON FILM, 1/4W 5%	4.7 K	R25472J	R5,8,30,33,61,64,96,106,122
13	382250103J	20	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R1-3,26-28,57-59,92,95,100,103, R110,113,118,121,123,127,128
14	382250123J	30	RESISTOR, CARBON FILM, 1/4W 5%	12 K	R25123J	R14-19,39-50,70-81
15	387342021K	18	RESISTOR, VAR, PC MT, 1/2W 10%	2 K	467S202A	R20-25,51-56,82-87
16	5203563P2X	10	TRANSISTOR	PN3563-18	PN3563-18	Q74,75,76,78,79,80,82,83,84,87
17	5203568PXX	65	TRANSISTOR	PN3568	2N3568	Q1-Q14,Q21-Q34,Q41-Q60,Q67-Q73, Q77,Q81,85,86,88-93
18	5203638PXX	18	TRANSISTOR	PN3638-5	PN3638-5	Q15-Q20,Q35-Q40,Q61-Q66,
20	645230202X	2	RACK, CARD, EJECTOR		S202	E1,2
21	80030X02C1	1	PC FAB, D/A RANGE	ALL PX30	PX30-02C	

900A3024X1 IEEE INTERFACE A15

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1016104D1K	2	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	
2	1022101P3J	1	CAPACITOR, DM 5%	100 PF	100 PF	C5
3	1022430P3J	1	CAPACITOR, DM 5%	43 PF	43 PF	C4
4	1071475C2K	1	CAPACITOR, TANTALUM, 10V 10%	4.7 UF	150D475X9010A2	
5	1636024XX1	1	CONNECTOR, BLUE RIBBON, IEEE	IEEE	57-20240-8	
6	1641026X1P	1	CONNECTOR, RIBBON, HEADER STR	26 PIN STR	050-026-153	
7	260400004X	1	INTEGRATED CIRCUIT	LS04	LS04	U5
8	260400074X	1	INTEGRATED CIRCUIT	LS74	LS74	U7
9	260400221X	1	INTEGRATED CIRCUIT	LS221	LS221	U6
10	2605034463	4	INTEGRATED CIRCUIT	MC3446AP	MC3446AP	U1,2,3,4
11	382240222J	2	RESISTOR, CARBON FILM 1/4W 5%	2.2K	R25222J	R1,2
12	4406765B07	1	SWITCH, DIP, 7 POS		76SB07/206-7	S1,2,3,4,5,6,7
13	601044004X	2	SCREW, PAN HD PHIL SS	4-40 X 1/4	MS51957-12	
14	645800440X	2	STANDOFF, SPACER M/F	4-40 X 1/4	8216	
15	80030X24X1	1	PC FAB, IEEE INTERFACE	PX32	PX30-24	

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	10113R3Q1K	1	CAPACITOR, CER DISK, 1000V 5%	3.3 PF	DD3R3	C15
2	1012100Q1J	1	CAPACITOR, CER DISK, 1000V 5%	10 PF	DD100	C37
3	1012180Q1J	2	CAPACITOR, CER DISK, 1000V 5%	18 PF	DD180	C1,2
4	1016104D1K	9	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	C4,6,7,8,27,28,30,31,39
5	1016104J1J	10	CAPACITOR, CER DISK, 100V 5%	.1 UF	CZ20A104Z	C16-19,21,22,24,25,35,36
6	1016474A1L	2	CAPACITOR, CER DISK, 3 V 20%	.47 UF	UK474	C5,9
7	1023101P3J	1	CAPACITOR, DM, 500V 5%	100 PF	DM15-101J	C10
8	1024102P3J	1	CAPACITOR, DM, 500V 5%	1000 PF	DM15-102J	C11
9	1033107J7X	2	CAPACITOR, ELECTROLYTIC, 50V	100 UF	ECEACV471	C33,34
10	1055103J5J	1	CAPACITOR, MYLAR, 50V 5%	.01 UF	711D1AA103PJ201AX	C12
11	1056104J5J	1	CAPACITOR, MYLAR, 50V 5%	.1 UF	711D1AC104PK201AX	C13
12	1057105J5J	1	CAPACITOR, MYLAR, 50V 5%	1 UF	711D1AG105PJ201AX	C14
13	1071475C2K	4	CAPACITOR, TANTALUM, 10V 10%	4.7 UF	150D475X9010A2	C3,29,32,38
14	1071475J2K	3	CAPACITOR, TANTALUM, 50V 10%	4.7 UF	150D475X9050B2	C20,23,26
15	140100685X	1	CHOKE, FIXED	6.8 UF	W68G	L3
16	1623001001	1	CONNECTOR, PLUG, MIN		51-007-000-220	
17	182281004X	4	DIODE, HOT CARRIER		5082/2810	CR1,8,9,10
18	18507510XK	1	DIODE, ZENER, 400 ma	5.1 V	1N751A	CR22
19	186445002X	18	DIODE, GEN PURPOSE		1N4450	CR2-7,11-21,23
20	362010024X	6	RELAY, REED, SPST	SPST	101-100-24	K1-6
21	3812104R7J	1	RESISTOR, CARBON COMP, 1/4W 5%	4.7 OHM	RC07GF4R7J	PART OF L4 (4.7T16)
22	381220470J	1	RESISTOR, CARBON COMP, 1/4W 5%	47 OHM	RC07GF470J	PART OF L2 (47T12)
23	381230101J	1	RESISTOR, CARBON COMP, 1/4W 5%	100 OHM	RC07GF101J	PART OF L1 (100T12)
24	382220270J	3	RESISTOR, CARBON FILM, 1/4W 5%	27 OHM	R25270J	R61,62,63
25	382220330J	5	RESISTOR, CARBON FILM, 1/4W 5%	33 OHM	R25330J	R24,26,33,35,70
26	382220470J	1	RESISTOR, CARBON FILM, 1/4W 5%	47 OHM	R25470J	R109
27	382230101J	11	RESISTOR, CARBON FILM, 1/4W 5%	100 OHM	R25101J	R2,5,6,8,9,14,17,19,20,28,32
28	382230121J	2	RESISTOR, CARBON FILM, 1/4W 5%	120 OHM	R25121J	R46,53
29	382230151J	1	RESISTOR, CARBON FILM, 1/4W 5%	150 OHM	R25151J	R4
30	382230271J	2	RESISTOR, CARBON FILM, 1/4W 5	270 OHM	R25271J	R16,32
31	382230331J	3	RESISTOR, CARBON FILM, 1/4W 5%	330 OHM	R25331J	R10,12,13
32	382230391J	2	RESISTOR, CARBON FILM, 1/4W 5%	390 OHM	R25391J	R25,34
33	382230471J	6	RESISTOR, CARBON FILM, 1/4W 5%	470 OHM	R25471J	R1,3,7,58,59,60
34	382230561J	2	RESISTOR, CARBON FILM, 1/4W 5%	560 OHM	R25561J	R34,38
35	382230681J	1	RESISTOR, CARBON FILM, 1/4W 5%	680 OHM	R25681J	R72
36	382230751J	2	RESISTOR, CARBON FILM, 1/4W 5%	750 OHM	R25751J	R49,54
37	382240102J	12	RESISTOR, CARBON FILM, 1/4W 5%	1 K	R25102J	R18,45,48,80,84,88,92,95, R98,101,104,107
38	382240122J	6	RESISTOR, CARBON FILM, 1/4W 5%	1.2 K	R25122J	R11,22,30,31,36,89
39	382240152J	4	RESISTOR, CARBON FILM, 1/4W 5%	1.5 K	R25152J	R79,81,85,89
40	382240222J	1	RESISTOR, CARBON FILM, 1/4W 5%	2.2 K	R25222J	R113
41	382240272J	1	RESISTOR, CARBON FILM, 1/4W 5%	2.7 K	R25272J	R93
42	382240332J	4	RESISTOR, CARBON FILM, 1/4W 5%	3.3 K	R25332J	R75,96,108,114
43	382240392J	3	RESISTOR, CARBON FILM, 1/4W 5%	3.9 K	R25392J	R68,69,71
44	382240472J	1	RESISTOR, CARBON FILM, 1/4W 5%	4.7 K	R25472J	R50
45	382240562J	3	RESISTOR, CARBON FILM, 1/4W 5%	5.6 K	R25562J	R23,37,99
46	382240682J	7	RESISTOR, CARBON FILM, 1/4W 5%	6.8 K	R25682J	R21,40,41,42,43,44,111
47	382250103J	3	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R74,102,105
48	382250153J	1	RESISTOR, CARBON FILM, 1/4W 5%	15 K	R25153J	R67
49	382250183J	2	RESISTOR, CARBON FILM, 1/4W 5%	18 K	R25183J	R15,110
50	382250273J	1	RESISTOR, CARBON FILM, 1/4W 5%	27 K	R25273J	R73
51	382250333J	2	RESISTOR, CARBON FILM, 1/4W 5%	33 K	R25333J	R51,115

900A3006C1 OUTPUT A10 (CONT)

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
52	382250473J	1	RESISTOR, CARBON FILM, 1/4W 5%	47 K	R25473J	R39
53	382330101J	1	RESISTOR, CARBON FILM, 1/2W 5%	100 OHM	R50101J	R29
54	383131240F	1	RESISTOR, FIXED FILM, 1/8W 1%	124 OHM	RN60D1240F	R97
55	383132490F	1	RESISTOR, FIXED FILM, 1/8W 1%	249 OHM	RN60D2490F	R100
56	383134990F	1	RESISTOR, FIXED FILM, 1/8W 1%	499 OHM	RN60D4990F	R103
57	383141001F	1	RESISTOR, FIXED FILM, 1/8W 1%	1 K	RN60D1001F	R106
58	384330101G	9	RESISTOR, METAL FILM, 1/2W 2%	100 OHM	RL20S101G	R76,77,82,83,86,87,90,91,94
59	384430101G	3	RESISTOR, METAL FILM, 1W 2%	100 OHM	RL32S101G	R55,56,57
60	384530101G	2	RESISTOR, METAL FILM, 2W 2%	100 OHM	RL42S101G	R64,66
61	387331011K	1	RESISTOR, VAR, PC MT, 1/2W 10%	100 OHM	467S101A	R27
62	387342021K	1	RESISTOR, VAR, PC MT, 1/2W 10%	2 K	467S202A	R47
63	480012106X	5	TOROID, FERRITE CORE, PULSE T	CF121-06	F867-1-06	T1,T2,FB1
64	52023690XX	1	TRANSISTOR	2N2369	2N2369	Q26
65	5203563P2X	11	TRANSISTOR	PN3563-18	PN3563-18	Q3,4,7,8,11,16,20,21,22,23,42
66	5203568PXX	10	TRANSISTOR	PN3568-5	PN3568-5	Q12,33,41
67	5203638PXX	1	TRANSISTOR	PN3638-5	PN3638-5	Q19
68	5203640P2X	19	TRANSISTOR	PN3640-18	PN3640-18	Q1,2,5,6,9,10,13,14,15,17,18, Q24,25,27,28,29,31,32,43
69	5251321XXX	1	TRANSISTOR, FET	MRF321	MRF321	Q30
70	6426000002	1	GROMMET, 1/40D 1/8ID		91114	
71	645000001X	2	POTTING CUP, PULSE TRANS			T1,T2
72	645230202X	2	RACK, CARD, EJECTOR		S202	E1,2
73	6468236502	3	TERMINAL, STAKED		3650-B SILVER	
74	80030X06C1	1	PC FAB, OUTPUT	ALL PX30	PX30-06C	

900A3009C1 MEMORY LATCH A5, A12

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1016104D1K	6	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	C1,2,3,4,5,6
2	267400000A	2	INTEGRATED CIRCUIT	7400	7400	U15,16
3	267400002A	4	INTEGRATED CIRCUIT	7402	7402	U17,18,19,20
4	267400075C	14	INTEGRATED CIRCUIT	74LS75	74LS75	U1-14
5	645230202X	2	RACK, CARD, EJECTOR		S202	E1,2
6	80030X09C1	1	PC FAB, MEMORY LATCH	PX32/32G	PX30-09C	

900A3004C1 OFFSET/AMPLITUDE A13

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1016104D1K	1	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	C1
2	28440020XX	2	DIODE, RECTIFIER, 1 A, 200 V		1N4002	CR27,28
3	186445002X	50	DIODE, GEN PURPOSE		1N4450	CR1-26,29-52
4	362000024X	16	RELAY, REED, SPST	SPST	101-100-24	K1-16
5	382240102J	4	RESISTOR, CARBON FILM, 1/4W 5%	1 K	R25102J	R35,36,42,45
6	382240222J	3	RESISTOR, CARBON FILM, 1/4W 5%	2.2 K	R25222J	R37,38,43
7	382240332J	31	RESISTOR, CARBON FILM, 1/4W 5%	3.3 K	R25332J	R2,6,10,14,18,22,26,30,34,41,46, R47,50,51,55,56,60,61,65,66,70, R71,75,76,80,81,85,86,90,91,93,
8	382240682J	16	RESISTOR, CARBON FILM, 1/4W 5%	6.8K	R25682J	R3,7,11,15,19,23,27,31,52,57, R62,67,72,77,82,87
9	382250103J	20	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R1,5,9,13,17,21,25,29,33,40,49, R54,59,64,69,74,79,84,89,92
10	382250223J	1	RESISTOR, CARBON FILM, 1/4W 5%	22 K	R25223J	R48
11	382250473J	10	RESISTOR, CARBON FILM, 1/4W 5%	47 K	R25473J	R39,44,53,58,63,68,73,78,83,88
12	3831237R4F	1	RESISTOR, FIXED FILM, 1/8W 1%	37.4 OHM	RN60D37R4F	R4
13	3831275R0F	1	RESISTOR, FIXED FILM, 1/8W 1%	75 OHM	RN60D75R0F	R8
14	383131500F	1	RESISTOR, FIXED FILM, 1/8W 1%	150 OHM	RN60D1500F	R12
15	383133010F	1	RESISTOR, FIXED FILM, 1/8W 1%	301 OHM	RN60D3010F	R16
16	383133740F	1	RESISTOR, FIXED FILM, 1/8W 1%	374 OHM	RN60D3740F	R20
17	383137500F	2	RESISTOR, FIXED FILM, 1/8W 1%	750 OHM	RN60D7500F	R24,28
18	383141501F	1	RESISTOR, FIXED FILM, 1/8W 1%	1.5K	RN60D1501F	R32
19	5203568PXX	52	TRANSISTOR	PN3568-5	PN3568-5	Q1-52
20	645230202X	2	RACK, CARD, EJECTOR		S202	E1,2
21	80030X04C1	1	PC FAB, OFFSET/AMPLITUDE	ALL PX30	PX30-04C	

900A3007C1 OUTPUT POWER SUPPLY A8

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1014102Q1J	3	CAPACITOR, CER DISK, 1000V 5%	.001 UF	DD102	C1,10,17
2	1015103P2K	2	CAPACITOR, CER DISK, 500V 10%	.01 UF	5GAS-S10	C5,13
3	1016104D1K	3	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	C14,18,20
4	1016104J1J	5	CAPACITOR, CER DISK, 100V 5%	.1 UF	CZ20A104Z	C2,7,9,11,16,
6	1071475C2K	2	CAPACITOR, TANTALUM, 10V 10%	4.7 UF	150D475X9010A2	C15,19
6	1071475J2K	4	CAPACITOR, TANTALUM, 50V 10%	4.7 UF	150D475X9050B2	C3,4,8,12
7	18507510XK	2	DIODE, ZENER, 400 ma	5.1 V	1N751A	CR1,16
8	18507540XK	1	DIODE, ZENER, 400 ma	6.8 V	1N754A	CR2
9	18547490XK	1	DIODE, ZENER, 1 A	24 V	1N4749A	CR11
10	186445002X	14	DIODE, GEN PURPOSE		1N4450	CR3-10,12-15,17,18
11	362000124X	1	RELAY, REED, SPDT	SPDT	101-001-24	K1
12	382220220J	1	RESISTOR, CARBON FILM, 1/4W 5%	22 OHM	R25220J	R33
13	382220680J	1	RESISTOR, CARBON FILM, 1/4W 5%	68 OHM	R25680J	R22
14	382230101J	5	RESISTOR, CARBON FILM, 1/4W 5%	100 OHM	R25101J	R7,8,13,46,73
15	382230151J	2	RESISTOR, CARBON FILM, 1/4W 5%	150 OHM	R25151J	R12,30
16	382230221J	2	RESISTOR, CARBON FILM, 1/4W 5%	220 OHM	R25221J	R14,62
17	382230331J	1	RESISTOR, CARBON FILM, 1/4W 5%	330 OHM	R25331J	R68
18	382230471J	1	RESISTOR, CARBON FILM, 1/4W 5%	470 OHM	R25471J	R23
19	382230561J	1	RESISTOR, CARBON FILM, 1/4W 5%	560 OHM	R25561J	R64
20	382230681J	4	RESISTOR, CARBON FILM, 1/4W 5%	680 OHM	R25681J	R3,4,49,67
21	382230821J	2	RESISTOR, CARBON FILM, 1/4W 5%	820 OHM	R25821J	R10,28
22	382240102J	14	RESISTOR, CARBON FILM, 1/4W 5%	1 K	R25102J	R19,38-44,48,53-56,72
23	382240122J	1	RESISTOR, CARBON FILM, 1/4W 5%	1.2 K	R25122J	R16
24	382240152J	7	RESISTOR, CARBON FILM, 1/4W 5%	1.5 K	R25152J	R15,24,35,45,52,65,66
25	382240222J	2	RESISTOR, CARBON FILM, 1/4W 5%	2.2 K	R25222J	R57,71
26	382240332J	5	RESISTOR, CARBON FILM, 1/4W 5%	3.3 K	R25332J	R34,36,50,58,63
27	382240392J	1	RESISTOR, CARBON FILM, 1/4W 5%	3.9 K	R25392J	R25
28	382240472J	1	RESISTOR, CARBON FILM, 1/4W 5%	4.7 K	R25472J	R20
29	382240682J	4	RESISTOR, CARBON FILM, 1/4W 5%	6.8 K	R25682J	R6,37,47,69
30	382250103J	1	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R51
31	382250153J	1	RESISTOR, CARBON FILM, 1/4W 5%	15 K	R25153J	R61
32	3823102R7J	4	RESISTOR, CARBON FILM, 1/2W 5%	2.7 OHM	R502R7J	R9,11,27,29
33	382340392J	1	RESISTOR, CARBON FILM, 1/2W 5%	3.9 K	R50392J	R1
34	382340472J	2	RESISTOR, CARBON FILM, 1/2W 5%	4.7 K	R50472J	R17,32
35	383142491F	2	RESISTOR, FIXED FILM, 1/8W 1%	2.49 K	RN60D2491F	R18,26
36	383144991F	1	RESISTOR, FIXED FILM, 1/8W 1%	4.99 K	RN60D4991F	R31
37	387341001G	1	RESISTOR, VAR, PC MT, 1/2W 10%	100 OHM	467S100A	R59
38	387341021K	5	RESISTOR, VAR, PC MT, 1/2W 10%	1 K	467S102A	R2,5,21,60,70
39	52006970XX	1	TRANSISTOR	2N697	2N697	Q34
40	5203563P2X	1	TRANSISTOR	PN3563-18	PN3563-18	Q11
41	5203568PXX	12	TRANSISTOR	PN3568	PN3568	Q3,4,13,14,20-25,28,29
42	5203638PXX	5	TRANSISTOR	PN3638-5	PN3638-5	Q12,26,30,32,33
43	5203643PXX	1	TRANSISTOR	PN3643-5	PN3643-5	Q36
44	520371503X	2	TRANSISTOR	2N3715	2N3715	Q8,17
45	52037400XX	2	TRANSISTOR	2N3740	2N3740	Q9,18
46	52042350XX	1	TRANSISTOR	2N4235	2N4235	Q1
47	52042390XX	1	TRANSISTOR	2N4239	2N4239	Q2
48	520491903X	4	TRANSISTOR	2N4919	2N4919	Q6,10,15,19
49	520492203X	5	TRANSISTOR	2N4922	2N4922	Q5,7,16,27,35
50	524025004X	1	TRANSISTOR	2N5190/40250	2N5190/40250	Q31
51	6436010001	2	INSULATOR, MICA TO3		B52600F010	
52	6436010002	4	INSULATOR, NYLON SHOULDER			

900A3007C1 OUTPUT POWER SUPPLY A8 (CONT)

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
53	645230202X	2	RACK, CARD, EJECTOR		S202	E1,2
54	6468236502	4	TERMINAL, STAKED		3650-B SILVER	
55	70030X3021	1	HEAT SINK, TO66 DUAL		30-302-1	
56	700HSX3001	1	HEAT SINK, SINGLE TO66		HS-309-1	
57	700HSX3011	1	HEAT SINK, TO3 DUAL		HS-301-1	
58	80030X07C1	1	PC FAB, POWER SUPPLY, OUTPUT	ALL PX30	PX30-07C	

900A3005C1 RISE/FALL TIME A11

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	18440020XX	2	DIODE, RECTIFIER, 1 A, 200 V		1N4002	CR29,30
2	186445002X	44	DIODE, GEN PURPOSE		1N4450	CR1-28,31,46
3	362010024X	16	RELAY, REED, SPST	SPST	101-100-24	K1-16
4	382240122J	3	RESISTOR, CARBON FILM, 1/4W 5%	1.2 K	R25122J	R35,38,41
5	382240152J	2	RESISTOR, CARBON FILM, 1/4W 5%	1.5 K	R25152J	R42,46
6	382240222J	7	RESISTOR, CARBON FILM, 1/4W 5%	2.2 K	R25222J	R43,45,47,48,50,51,52
7	382240332J	16	RESISTOR, CARBON FILM, 1/4W 5%	3.3 K	R25332J	R2,6,10,14,18,22,26,30,54,58, R62,66,70,74,78,82
8	382240472J	3	RESISTOR, CARBON FILM, 1/4W 5%	4.7 K	R25472J	R34,37,40
9	382240682J	16	RESISTOR, CARBON FILM, 1/4W 5%	6.8 K	R25682J	R3,7,11,15,19,23,27,31,55,59, R63,67,71,75,79,83
10	382250103J	19	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R1,5,9,13,17,21,25,29,33,36, R39,53,57,61,65,69,73,77,81
11	382250183J	2	RESISTOR, CARBON FILM, 1/4W 5%	18 K	R25183J	R44,49
12	383131240F	2	RESISTOR, FIXED FILM, 1/8W 1%	124 OHM	RN60D1240F	R4,56
13	383132490F	2	RESISTOR, FIXED FILM, 1/8W 1%	249 OHM	RN60D2490F	R8,60
14	383134990F	2	RESISTOR, FIXED FILM, 1/8W 1%	499 OHM	RN60D4990F	R12,64
15	383141001F	2	RESISTOR, FIXED FILM, 1/8W 1%	1 K	RN60D1001F	R16,68
16	383141241F	2	RESISTOR, FIXED FILM, 1/8W 1%	1.24 K	RN60D1241F	R20,72
17	383142491F	2	RESISTOR, FIXED FILM, 1/8W 1%	2.49 K	RN60D2491F	R24,76
18	383144991F	2	RESISTOR, FIXED FILM, 1/8W 1%	4.99 K	RN60D4991F	R28,80
19	383151002F	2	RESISTOR, FIXED FILM, 1/8W 1%	10.00 K	RN60D1002F	R32,84
20	5203568PXX	43	TRANSISTOR	PN3568-5	PN3568-5	Q1-43
21	645230202X	2	RACK, CARD, EJECTOR		S202	E1,2
22	80030X05C1	1	PC FAB, RISE/FALL	30/32/32G	PX30-05C	

900A3023X2 IEEE CONTROL A3

LIST OF MATERIALS

ITEM	PART NO	QTY	DESCRIPTION	VALUE	MFG NO	REFERENCE DESIGNATION
1	1016104D1K	7	CAPACITOR, CER DISK, 12V 10%	.1 UF	UK12-104	C4,5,6,7,8,9,10
2	1071475C2K	3	CAPACITOR, TANTALUM, 10V 10%	4.7 UF	150D475X9010A2	C1,2,3
3	1641026I2P	1	CONNECTOR, RIBBON, HEADER, ANG	26 PIN	050-026-053	P2
4	1865820GIX	1	DIODE, GEN PURPOSE GERMANIUM	1N5820	1N5820	CR4 (10K PI32)
5	186445002X	5	DIODE, GEN PURPOSE	SIL	1N4450	CR1,2,3, (5,6)NU PX32
6	267400042A	1	INTEGRATED CIRCUIT	7442	7442	U1
7	267400002C	1	INTEGRATED CIRCUIT	74LS02	74LS02	U9
8	267400008X	1	INTEGRATED CIRCUIT	74LS08	74LS08	U13
9	267400032C	2	INTEGRATED CIRCUIT	74LS32	74LS32	U6,15
10	267400042C	1	INTEGRATED CIRCUIT	74LS42	74LS42	U17
11	267400075C	1	INTEGRATED CIRCUIT	74LS75	74LS75	U2
12	267400138C	4	INTEGRATED CIRCUIT	74LS138	74LS138	U4,5,14,16
13	267400193C	1	INTEGRATED CIRCUIT	74LS193	74LS193	U3
14	267400266C	2	INTEGRATED CIRCUIT	74LS266P	74LS266/8242	U10,11
15	267400279C	2	INTEGRATED CIRCUIT	74LS279	74LS279	U8,12
16	267400366C	1	INTEGRATED CIRCUIT	74LS366	74LS366/368	U7
17	382220220J	1	RESISTOR, CARBON FILM, 1/4W 5%	22 OHM	R25220J	R6
18	382240102J	2	RESISTOR, CARBON FILM, 1/4W 5%	1 K	R25102J	R1,5
19	382240222J	3	RESISTOR, CARBON FILM, 1/4W 5%	2.2 K	R25222J	R3,4,7
20	382240472J	1	RESISTOR, CARBON FILM, 1/4W 5%	4.7K	R25472J	R2 NOT USED PX32
21	382250103J	1	RESISTOR, CARBON FILM, 1/4W 5%	10 K	R25103J	R8 NOT USED PX32
22	5203568PXX	3	TRANSISTOR	PN3568-5	PN3568-5	Q1,2,3
23	645230202X	2	RACK, CARD, EJECTOR		S202	E1,2
24	80030X23X1	1	PC FAB, IEEE CONTROL	PX32/32G	PI30-23	